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A competitive examination of applicants for the positions of assistant engineers, levelers, rodmen and chainmen in the State Engineer's Department, New York, is to be held at Albany on Dec. 5, as announced in our advertising columns.

The Chicago Drainage Commission has practically decided to defer building the proposed seven or eight costly steel drawbridges over the drainage canal until a demand for them comes from the extended use of the canal as a commercial waterway. The majority of the trustees argue that there is no such demand in the immediate future, and will not be until the U. S. government improves the Illinois River to give an outlet from the lower end of the canal. The use of fixed spans instead of swing spans will make a large saving in expense, which, in view of the great amount of subsidiary work still remaining to be done, is an important matter.

The construction of a submarine torpedo boat, on the plans of the John P. Holland Torpedo Boat Co., of New York, has been approved by the Secretary of the Navy. This construction was first recommended by the Board of Bureau Chiefs. No details have yet been decided upon, but it is supposed that the Holland Co. will be instructed to build upon plans approved by the bureau. The Holland boat was described in our issue of Sept. 21, 1893.

The latest scheme for water-power development is reported from Sioux City, Iowa. The plan is to run an 8½-mile canal across from the Missouri River, near Burbank, to the Big Sioux River, near Elk Point. The fall would be 26.85 ft., and it is proposed to develop 4,000 HP. to run machinery in Sioux City, 20 miles distant. The originator of the scheme is Mr. B. S. Holmes, of Sioux City, and he estimates the cost at about $200,000. Surveys for the proposed work have been made by Mr. T. H. Johnson, formerly City Engineer of Sioux City.

The water-works of Gainesville, Ga., which are owned by the city, are to be operated under a contract by private parties, if all goes well. On Nov. 13 the Board of Aldermen instructed the clerk to advertise for bids for operating the plant and keeping it in repair. This is in line with the views of some students of municipal affairs, who hold that certain undertakings which are natural monopolies, like water and lighting plants and railways, should be owned and controlled by the public, but leased to private parties for operation.

The most serious railway accident of the week was the derailment of a coal car on a trestle at Latimer, Pa., on a branch of the Pennsylvania R. R., Nov. 19. A train of 16 cars was crossing the trestle when one of the cars was derailed and several others were piled up in a heap, the force of the shock causing the trestle to give way. Several miners were on the train and three or four were killed.

A locomotive boiler explosion occurred Nov. 15 near Nashua, N. H., on the Concord & Montreal R. R.; the engine was hauling a freight train at the time. One man was badly scalded. The engine had just come from the repair shops that morning.

A boiler in the street railway and electric power house at Elwood, Ind., exploded Nov. 16, killing one man and doing damage to the extent of $20,000.

A mine explosion attributed to coal dust occurred Nov. 20 in the Blanche coal mines, near Collier's, W. Va., seven miles east of Steubenville, O., by which seven men were killed and four badly injured. The disaster occurred in No. 9 entry, 3,000 ft. from the mouth, and was caused by a new Italian miner firing an overcharged blast, which ignited the coal dust. There were 48 men in the mine at the time. A similar accident occurred at this mine on Nov. 21, 1892, when three men were killed and seven burned and injured.

A section 60 ft. long of the heavy steel smokestack of the University Building in Dearborn St., near Madison St., Chicago, was blown down Nov. 20 and fell on the roof of an adjoining building, smashing the roof and skylight. Several people were injured by falling glass.

The "Greater Boston" project, now being discussed by the Metropolitan District Commission appointed by the last Massachusetts legislature, involves approximately the following areas in square miles: Boston proper, 39.66; postal district, 66.52; sewer district, 177.86; water, 247.73; parks, 400 square miles. The last would represent the total area included in the projected scheme. The population of the several districts of control are given as follows: Boston, 500,250; postal, 690,790; sewer, 878,360; water, 991,440; parks, 1,025,800; the latter figure representing the total population for "Greater Boston." The total assessed value of the 37 municipalities included is $1,455,000,000, and the increase in the last ten years was nearly 50%. While the Commission has expressed no final conclusion, it is practically decided to recommend a form of government similar to that of the County Council of London. The alternative is to leave in the hands of the state commissioners the management of these consolidated properties and the assessments on the cities and towns for their maintenance. The London plan involves the election of representatives from all the districts to control the general management, and perhaps the main highways and health, police and fire systems, and leave all else as it is now.

The approximate cost of obtaining 9 ft. of water in the New York State Canals is thus estimated by State Engineer Adams in his report to the late Constitutional Convention:

	Work.	Land Damages.	Total.
Erie	$4,810,000	$500,000	$5,310,000
Oswego	1,133,000	75,000	1,208,000
Champlain	4,000,000	300,000	4,300,000
Black River	8800,000	80,000	8,880,000
Cayuga and Seneca	240,000	20,000	260,000
Oneida	310,000	25,000	335,000
Totals	$19,293,000	$1,000,000	$20,293,000

Superintendent of Public Works Hannan left the Black River Canal out of his estimate, and figures that the Champlain Canal could be deepened for $1,831,000. The Canal Union people put the total cost of deepening all the canals to 9 ft. at about $18,000,000. Under the "canal amendment" in the new constitution, the State Legislature can now pass a bill authorizing the issue of bonds for this work; but such a bill must be submitted to a popular vote before it can become operative. The last legislature appropriated $100,000 to make a beginning in the deepening to 9 ft., and this money will be expended between Albany and Cohoes, on the Erie Canal.

The oft-repeated statement that Alabama can produce pig iron in competition with the world finds support in the recent bids for 10,000 tons of cast-iron water mains for the city of Tokio, Japan. The Howard-Harrison Iron Co., of Bessemer, Ala., were the lowest bidders in competition with English, German and Belgian pipe makers; but the contract was afterward declined by the firm, on account of the added risks due to the war, and the deliveries which the contract required.

The Nicaragua Canal bills now before the Senate and House of the Vermont legislature will doubtless be passed. The bills will incorporate the Nicaragua Co. and will grant a specific charter to construct an interoceanic canal across Nicaragua, with very wide powers. The capital stock is placed at $12,000,000, with power to increase it, and the incorporators are John R. Bartlett, Smith M. Weed, Henry J. Howland, Richard L. Edwards, John J. Emery, Wilhelmus Mynderse and E. K. Sibley. Hon. Warner Miller appeared before the legislative committee, together with the attorneys of the old Nicaragua Canal Construction Company, which this new company is to succeed. Mr. Miller said that the holders of the old stock had turned in all but 1,000 shares out of the 120,000 shares outstanding to the reorganization committee.

According to the report of the Second Assistant Postmaster-General, mail service is now in operation on 47 electric car lines, at rates fixed by law for the transportation of mail on steam roads. The routes are comparatively short, however, the longest being 18 miles. The electric car service is also being considered as a means of carrying mails in large cities between the main and branch offices and railway stations.

A new straight channel is reported, between the Galveston jetties, from 15¾ to 18 ft. deep. From an interview in the Dallas "News" with Major A. M. Miller, engineer officer in charge, we learn that the south jetty has been pushed gulfward 20,900 ft. and the stonework is within 1,000 ft. of the 18-ft. curve. The north jetty, which has so far cost $1,516,904, is completed for 12,200 ft. from the initial point. It is the intention to push both of these jetties out to the 30-ft. curve, and the south jetty is now 3,980 ft. and the north jetty 5,820 ft. inside of that point. The 18-ft. curve has advanced seaward 1,400 ft. in the three years consumed in jetty building, and the aim of the engineers is now to push out the jetties faster than this curve recedes. Major Miller says that no possible permanent improvement could take place until the north jetty was well out; and little was expected until the 18-ft. curve was reached. The jetties are now very near this curve, and he expects that the new channel is the beginning of the 18 to 20-ft. channel, which he hopes to secure without dredging. The inner curve of the bar has advanced seaward 5,800 ft., and vessels now ride safely at anchor in the protected inner roads, where formerly there was only 9 to 10 ft. of water at mean low tide.

A process for re-rolling steel rails has recently been patented by Mr. E. W. McKenna, late Assistant General Superintendent of the Chicago, Milwaukee & St. Paul Ry. By careful tests Mr. McKenna ascertained that a rail wears out by deformation of the head and not by actual loss of metal. Sections of 60-lb. rail, removed from the track and weighed, were found to have lost only 0.117 to 0.135 lb. per yd. in 10 to 14 years of service. He, therefore, devised a process by which the worn-out rails are heated in a furnace and the deformed heads are re-rolled into the proper form. The loss of transverse section in this re-rolling is about 2 lbs. per yd., of which part is gained as elongation, leaving the net loss only ½ lb. per yd. for oxidation and the same amount for loss in crop ends. By this process, which is said to be inexpensive to carry out, a steel rail of 75 lbs. or heavier can be renewed from five to fifteen times before its section is so greatly reduced as to make it necessary to scrap it. If Mr. McKenna's invention proves a practical success, the rail mills will have to close up or turn to other products. The demand for rails for renewals is what the rail mills have been chiefly relying on since speculative railway building came to an end.

The Boston shore of the Charles River has long been recognized as anything but attractive, for it is lined with stables and unsightly backyards and outbuildings. A committee of residents has recently presented to the Boston Park Commissioners two plans for improvement. Both contemplate extending the present sea wall out about 25 ft. and providing a promenade along the shore, with a screen of wall and shrubbery cutting off the alley and rear of the houses mentioned. The views presented in the Boston "Herald" are certainly attractive, though the question of probable cost to the city and to property-owners is not yet determined.

Enameled steel switch targets are being used in Canada with satisfactory results as substitutes for painted targets of iron and wood, and these targets are to be introduced in this country. The color will not fade, it is lighter than paint and can be easily washed, while it does not get dirty as soon as the rougher surface of paint. It is considered that the enameled target is more economical than the painted target, if the trouble and expense of maintenance of the latter are taken into account. These targets are manufactured by Noah L. Piper & Son, of Toronto, Ont.

LAYING A SUBMERGED WATER MAIN AT JERSEY SHORE, PA.

How to get water mains or other lines of pipe across streams most economically and with the greatest promise of durability and reliable service is one of the most interesting problems connected with the construction of hydraulic works. Local conditions often determine the plan to be adopted and the method to be employed; but there is generally a considerable range of choice left to the wide-awake engineer or contractor.

Since flexible joints have been so readily available for this work, it has become quite common practice to lay the pipe either in single lengths or in sections of several lengths from scows, the pipe already down resting on the river bottom up to the last flexible joint, and extending from this to the free end on the boat. For convenience, two scows are often used, placed across the stream, the pipe being lowered between them.

A 10-in. cast iron water main was recently laid beneath the Susquehanna River, near Jersey Shore, Pa., with Mr. Charles Herdic, of Addison, N. Y., as contractor, and Mr. Jas. P. Herdic, of Williamsport, as superintendent of the work. For the following account of the method employed, together with the photograph from which the accompanying view of the work in progress was made, we are indebted to Mr. Herdic:

At this point the current is so strong that a boat cannot hang suspended from a cable across the stream without swamping. I therefore adopted the plan, shown in the photograph, of suspending the boat head up stream, and laying the pipe off from the side of the boat. The boat was held steadily in place during the running of joints by ropes running from its upper and lower corners to the shore, in such a manner as to allow the current to strike the boat on the quarter which kept the boat ropes taut and the boat steady.

The line was successfully run, using one Ward flexible joint to every six lengths of regular pipe. While laying with one boat is not usually so convenient as laying with two, owing to lack of room to work and lack of carrying power, yet, for work in a rapid stream, one boat is a decided success.

This work was done for the Jersey Shore Water Co., of which Mr. Frank Trump is president. The submerged main forms a part of a new supply main from Augenbaugh's Run, 3,000 ft. up the mountain side, to a new distributing reservoir near the town and about 250 ft. above it.

LAYING A 10-IN. SUBMERGED CAST IRON WATER MAIN ACROSS THE SUSQUEHANNA RIVER, NEAR JERSEY SHORE, PA; Jas. P. Herdic, Superintendent of Work.

THE HARDENING OF MORTAR.

It has long been an accepted theory that the hardening of common lime mortar is due first to the transformation of the calcium hydrate to calcium carbonate by the absorption of carbonic acid gas from the air, and second to the formation of calcium silicate by the chemical combination of the lime and the sand. The latter has been supposed to take place very slowly, but to be in time an important factor in the hardening of mortar.

In a thesis presented by Mr. J. A. McPherson, of the graduating class of 1894, Rensselaer Polytechnic Institute, the results of experiments to test the correctness of this theory are described.

After extended experiments with mortar taken from the old Van Rensselaer mansion at Albany, built about 1760, and with mortar from a very ancient tower in the valley of the Lahu, the quantity of calcium silicate found therein was 0.34% of the total weight of the mortar, an amount altogether too small to be considered as a factor in the hardening of the mortar.

Mr. McPherson also tested the correctness of the common belief that it is better to let lime mortar lie in a heap some days after mixing before it is used than to use it immediately after mixing. The following table shows in condensed form the result of the test:

	Days in heap after mixing.	Days exposed to air as a briquette.	Average breaking weight in lbs. per sq. in.
Mortar No. 1.....	3	50	34.6
" "	4	49	38.6
" "	6	48	38.1
" "	7	46	39.3
Mortar No. 2.....	4	48	36.0
" "	5	47	38.0
" "	6	46	41.2
" "	7	45	41.5

Tests of the value of sugar in tempering cement mortar showed that the addition of ½ lb. sugar to 1 gallon of the water used in tempering, increased the tensile strength of briquettes left in the air 3.8%. With the briquettes immersed in water, the strength of the sugar briquettes was the same as that of the briquettes made without sugar. Tests of cement mortar in which bullock's blood diluted with one-third its volume of water was used for tempering, showed a gain of 10% where the briquettes were left in air, and a gain nearly as great where they were immersed in water.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 498, Vol. XXI.)

Results with the Chemical Precipitation of Sewage at the World's Columbian Exposition.

As most of our readers will remember, the sewage of the World's Columbian Exposition was purified by chemical precipitation before being discharged into Lake Michigan. It was thought that the plant employed for this purpose afforded an excellent opportunity for studying, on a large scale, the subject of chemical precipitation and the value of different chemicals. Accordingly Mr. Allen Hazen, for many years chemist in charge of the Lawrence Experiment Station, was secured to superintend the precipitation of the sewage. Under Mr. Hazen's direction large numbers of chemical and bacteriological analyses of the sewage were made, both before and after treatment. The results of these analyses and of Mr. Hazen's observations on the plant have just been made public through a paper by him in the report of the Massachusetts State Board of Health for 1893. The opening part of the paper, with slight condensation, is as follows:

The sewage disposal works at the World's Columbian Exposition were described in the Engineering News of Aug. 3, 1893, which contains drawings showing many of the details of construction and arrangement. The works consisted in brief of four cylindrical iron settling tanks of the Roeckner-Rothe type, 32 ft. high and 32 ft. in diameter, with conical bottoms, which, in a height of 22 ft., tapered from 32 ft. to 6 ft. The total height was thus 54 ft., and the capacity of each tank, as ordinarily used with sewage standing 18 ins. below the top, was 237,000 gallons.

The sewage from the various buildings on the Exposition grounds was forced by Shone ejectors to the precipitating tanks. The sewage passed down through central cylinders, 6 ft. in diameter, to points near the bottoms of the tanks, where it was distributed by sheet-iron arms, and the precipitate settled to the bottom, while the clarified liquid, ready for discharge into the lake, slowly rose to the top, where it was removed by a set of troughs drawing as nearly as possible equal quantities of effluent from equal areas of surface to give a uniform and regular upward movement to the sewage in the tanks. The sludge which settled to the conical-shaped bottom was expected to slide to the point of the cone, where there was an outlet through which it could be drawn off from time to time for pressing without interrupting the continuous action of the tanks.

The filter-presses, which were exhibited by the Perrin Co., Chicago, were made by the G. H. Bushnell Co., Thompsonville, Conn., and produced at each operation 50 cakes of sludge 36 ins. in diameter and about 1⅝ ins. thick, weighing about 47 lbs. each. The central passages in the filter-presses were 4 ins. in diameter, but it was found that rags and cotton waste which passed the bars in the screen, about ¾ in. apart, would frequently stop the 4-in. holes in the plates, allowing the pressure to accumulate on one side of the plate until it broke. The delay and expense of replacing plates were considerable, and it was not until the screen was covered with a finer wire screen to retain all rags and the holes in the plate were cut out to 6 ins. in diameter that satisfactory working was obtained. The quantity of sludge which could be pressed with these presses was much below the anticipated amount, and the failure to press promptly the sludge as produced was often the limit, during a large part of the summer, of the efficiency of the plant.

The sludge cake, together with the garbage from the grounds, was burned in an Engle crematory near the sewage-disposal works.

The object of having four separate settling tanks, each of them with its independent appliances for mixing chemicals, was to allow the simultaneous application of different chemicals to sewage of precisely the same composition, and to secure in that way definite comparisons between the different chemicals when working upon a large scale. Such experiments were made almost from the first, but it soon became apparent that, within wide limits at least, the chemicals employed were not the controlling or even the leading factor in the results obtained, and that the differences between the various quantities or kinds of chemicals were often far more than offset by other conditions which will be described beyond, over which we had less control. In this way, our investigations, instead of throwing light upon the questions which we had propounded, have been mainly confined to quite another set of problems which were scarcely anticipated before they presented themselves. We found it necessary to study, not so much how to produce a precipitate by adding chemicals to the sewage, as how to make it settle to the bottom and stay there until it could be removed and pressed.

One of the most troublesome circumstances in connection with the plant was the irregular manner in which the sewage was delivered at the works. The flow of sewage, instead of coming regularly, was subject to violent fluctuations, due to the method of collection and to the construction of the force main. The sewage was forced into this main by 26 pairs of Shone ejectors located at various points on the grounds. These were operated by compressed air from a central station in Machinery Hall, and each was furnished with an automatic appliance to shut off the air as soon as the tank was sufficiently emptied. For some reason these valves often failed to act as was intended, and the compressed air followed the sewage into the pipes in large quantity, pushing ahead of it the sewage in the sewer pipes with great rapidity to the precipitation works. The sewer pipes, having been laid with-

out attention to grades, contained numerous summits and depressions, and the air rapidly accumulated in the summits, until finally the bulk of the sewage in the sewers had to be forced to the works when at last the air commenced to come through the vertical discharge pipe. This at once relieved the pressure, and the large volume of air contained in the sewers, now rapidly expanding and mixed with varying proportions of sewage, came out with explosive violence, throwing quantities of sewage into the air and even through the roof. The violence of these "blows" can be somewhat appreciated when it is stated that most of the glass in the roof 20 ft. above the outlet was broken by these "blows" within a few days after the works were started, and that among other debris, a piece of lead weighing 9 lbs., which had been accidently left in the sewers, was carried up through and discharged from the vertical pipe 50 ft. in height.

The number of days in each month on which such "blows" occurred, usually from one to ten and sometimes even as many as twenty "blows" occurring in a single day, was as follows:

	No. days.	Per cent. of total No. of days.
April (14 to 30)	13	76
May	23	74
June	13	43
July	15	48
August	19	61
September	22	73
October	26	84

The average maximum hourly flow of sewage was about 6% of the total daily flow, and the latter never exceeded 3,200,000 gallons; it may thus be said that the normal flow of sewage which should have been obtained, if it had been delivered at the same rate as it was produced, would not have exceeded 190,000 gallons per hour, and this quantity would produce a velocity of only 1 ft. per sec. in the 3-ft. discharge pipe. Actually, the ordinary discharge between "blows" was much less than this, and allowed much of the suspended matter of the sewage to be deposited on the bottom of the sewer. Every time a "blow" occurred, the matter which had been deposited since the previous "blow" was flushed out, and at these times sewage was obtained two or three times as concentrated as at other times. Thus for short intervals enormous quantities of highly concentrated sewage were received at the works, and the rest of the time only a reduced flow of a sewage from which the sludge had been partially removed, and frequently for a time after the "blows" occurred there was no flow at all.

The chemicals employed as precipitants were copperas or crude ferrous sulphate, crude alum or sulphate of alumina, a crude ferric sulphate, and lime. The copperas, alum or ferric sulphate was first added to the sewage, which then passed through a mechanical mixer containing a rapidly revolving paddle-wheel, and then received the lime. The mechanical mixers for mixing the chemicals with the sewage had no advantage over a fishway, and were more expensive and troublesome in construction and operation.

It was found that the sludge produced with copperas and lime as precipitants was much more easily pressed than that with alum even when used with lime; and as the cost of pressing the sludge exceeded the cost of precipitating, copperas was a more economical precipitant than alum. For the same reason more lime was used with alum than was necessary to produce the best effluent, because the sludge produced in presence of an excess of lime could be much more easily pressed, and the extra lime applied to the sewage was cheaper than the labor on the presses. For equal costs of treatment copperas and alum produced equally good effluents, although the effluent from copperas had more color (due to the suspended iron) than that from alum. The only ferric sulphate obtainable contained much free acid, with a disappointingly low percentage of soluble ferric oxide, and the rather poor results obtained should not be taken as disparaging the use of a better quality of reagent.

The quantities of sewage passing each tank were determined by hourly weir measurements, so that the total daily flow of sewage was calculated from 96 readings. The method of obtaining the samples was to mix eight pint samples in a gallon bottle, the eight portions being taken at such intervals that one-eighth of the total daily flow passed between each two of them. The samples of effluent were taken in the same way, but as much later than the corresponding sewage samples as the average time required for the sewage to pass through the tanks.

The analyses are believed to represent correctly the character of effluent as discharged into Lake Michigan; but, owing to the violent fluctuations in the flow of the sewage mentioned above, the samples of sewage taken represent in general the sewage between "blows," when it did not contain the full amount of sludge, as, owing to the personal danger involved, satisfactory samples could not be obtained during "blows," and even if they could have been collected, it would have been impossible to determine how much sewage actually had the composition indicated by the samples. For this reason the results for loss on ignition, albuminoid ammonia and oxygen consumed in the unfiltered sewage are too low and the results of efficiency given* must be taken as relative instead of absolute. The soluble constituents, including chlorine and free ammonia, were not affected in the least by sedimentation.

Mr. Hazen next presents the results of his analyses in the shape of averages for six four-week periods, giving in great detail the composition of the sewage, the average of all the effluents and the effluents of each tank for each period and including temperatures in each case. These figures have been condensed into the accompanying Table I.

TABLE I.—Analyses of Sewage and Effluents, World's Columbian Exposition.

	Solids.	Chlorine.	Oxygen consumed.	Ammonia, Albuminoid.	Ammonia, Free.	Bacteria per cu. cm., In millions.
June 10 to July 7, 1893.						
Sewage	58.3	6.32	3.05	.80	3.67	5.6
Aver. of all effluents	42.7	5.00	1.37	.36	2.98	6.2
Effluent of Tank 1	43.2	5.31	1.45	.38	3.10	5.4
" " " 2	44.0	5.25	1.44	.39	3.10	7.5
" " " 4	40.9	4.42	1.22	.32	2.74	5.8
July 8 to Aug. 4.						
Sewage	47.4	4.65	2.45	.62	2.52	3.3
Aver. of all effluents	39.5	4.40	1.32	.33	2.60	7.7
Effluent of Tank 1	41.2	4.58	1.45	.37	2.72	7.3
" " " 2	40.8	4.42	1.37	.34	2.64	6.9
" " " 3	38.9	4.47	1.37	.35	2.67	10.3
" " " 4	37.0	4.13	1.10	.28	2.38	6.2
Aug. 5 to Sept. 1.						
Sewage	60.0	5.55	2.81	.85	3.52	4.5
Aver. of all effluents	46.9	5.14	1.54	.46	3.55	11.5
Effluent of Tank 1	49.5	5.31	1.69	.50	3.67	9.4
" " " 2	49.8	5.23	1.66	.48	3.72	15.8
" " " 3	48.6	5.36	1.63	.50	3.86	8.6
" " " 4	39.6	4.67	1.20	.36	2.97	12.3
Sept. 2 to 29.						
Sewage	62.2	5.64	3.23	.86	4.84	2.5
Aver. of all effluents	52.8	5.53	1.88	.49	3.95	7.0
Effluent of Tank 1	53.6	5.71	2.03	.54	3.80	3.8
" " " 2	52.7	5.33	1.77	.46	4.16	9.5
" " " 3	55.9	5.54	2.04	.52	4.36	7.5
" " " 4	49.2	5.53	1.60	.43	3.48	7.2
Sept. 30 to Oct. 27.						
Sewage	64.0	5.81	3.64	.90	4.87	2.2
Aver. of all effluents	54.1	6.11	2.12	.61	4.11	5.9
Effluent of Tank 1	56.2	6.14	2.27	.64	3.47	3.6
" " " 2	50.9	5.32	1.77	.53	4.45	10.0
" " " 3	55.6	6.57	2.34	.67	4.71	6.8
" " " 4	53.5	6.41	2.09	.62	3.80	3.1

In relation to the bacteriological results, Mr. Hazen says:

One of the most striking features of the analyses is the excessive number of bacteria found in the effluents, several times as many as in the crude sewage. The causes of this remarkable condition were investigated by Drs. Wilson and Agar, of the United States Army Hospital. The results obtained show that, while the sewage contained a great variety of species of bacteria, the effluents contained only a few species in large numbers, and these forms were very much more abundant than in the crude sewage. It appears that the bulk of the bacteria of the sewage was taken to the bottoms of the tanks in the precipitate, and did not exist in the effluents. The tanks, however, served as a breeding place for enormous numbers of the species found in the effluents, which were, presumably, non-pathogenic, for, as far as we know, the pathogenic forms sometimes found in water are probably incapable of growing in the conditions present in the tanks. The treatment may be said to have secured a partial but probably very incomplete removal of objectionable bacteria.

The quantities of sewage treated and chemicals employed for each tank during the different periods and the cost of the chemicals are shown in Table II.

The average composition of the sludge from all the tanks was 58% of moisture and 42% of dry matter. The dry matter showed 55.6% of ash, 44.4% of loss on ignition (in a radiator) and 8.2% of fats. The presses were but rarely able to handle the sludge promptly as produced, and on July 13 and Sept. 4 to 6 unpressed sludge was discharged into the lake in order to avoid a nuisance at the works. In October a slight accidental discharge was made. The total amount thus discharged into the lake was about 50 tons out of a total of 1,364 tons produced from April 15 to Oct. 27. On Oct. 27 there remained unpressed 30 tons of sludge, so that the actual amount pressed during the period was 1,284 tons. The 1,364 tons of sludge was produced from 373,000,000 tons of sewage, the average per million gallons having been 3.5 tons. The percentage of sludge gradually increased during the season from 2 tons at the start to 48 tons per million gallons.

TABLE II.—Operation of Each Sewage Precipitation Tank.

Tank.	Per cent. of organic matter removed.*	Suspended matter in effluent, parts per 100,000.	Daily quantity treated, thousands of gallons. Average.	Daily quantity treated, thousands of gallons. Maximum.	Cost and pounds of chemicals per one million gallons. Cost ($).	Lime.**	Copperas.	Alum.	Ferric sulphate.
June 10 to July 7, 1893.									
1	53	5.7	598	806	$7.44	752	615	..	..
2	52	5.4	598	592	8.17	412	..	623	..
3	Not in operation.								
4	60	2.8	465	642	10.30	556	..	703	..
July 8 to Aug. 4.									
1	41	6.4	605	765	5.79	744	376	..	..
2	45	5.7	598	749	7.40	435	..	542	..
3	44	6.8	604	786	8.21	731	755	..	..
4	55	3.8	454	512	9.20	626	363	396	..
Aug. 5 to Sept. 1.									
1	41	9.6	693	860	6.71	1,033	335	..	..
2	43	6.9	690	863	7.12	496	..	488	..
3	42	7.8	693	840	8.82	1,003	671	..	..
4	58	5.1	449	514	9.70	1,079	744	..	..
Sept. 2 to Sept. 29.									
1	38	5.9	651	912	7.03	1,000	391	..	..
2	46	3.2	572	908	8.76	520	..	645	..
3	39	7.1	665	942	8.54	854	357	..	175
4	51	4.1	565	770	11.16	1,278	820	..	..
Sept. 30 to Oct. 27.									
1	34	7.2	674	809	6.70	1,050	504	..	..
2	46	5.2	522	604	9.48	677	..	723	..
3	31	5.9	666	828	9.18	793	..	..	417
4	37	4.1	679	832	10.82	1,300	1,002	..	..

*The percentage purification indicated by these figures is too low, owing to the partial sedimentation of the sewage analyzed. The efficiency of the plant as a whole is discussed beyond. The figures for each period, however, are comparable among themselves.

**When dolomite lime was employed only two-thirds of its weight is used in this table.

The efficiency of the plant, as shown by the removal of organic matter in Tables I. and II., is below the actual efficiency, owing to the partial sedimentation of the sewage from which samples were taken, as already explained. From the relative amounts of organic matter in the sludge and the effluent, it appears that for the 20 weeks for which complete data are available, about 50% of the total organic matter was removed from the sewage.

The average amount of organic matter removed by the chemical precipitation works at Worcester, Mass., from July 19 to Dec. 1, 1893, was also about 50% (see Eng. News, March 8, 1894). For the week ending July 29, 1891, the average amount of organic matter removed at Worcester was 56%, as determined by a special examination made by the Massachusetts State Board of Health, while the experiments by the board at Lawrence indicated that 60% purification might be expected.

Mr. Hazen believes that the "disappointingly low efficiency of the plant is to be attributed solely to unfavorable conditions for sedimentation present in the tank." As compared with this the fluctuations in flow are considered as minor difficulties.

The slowness with which the sludge was handled was against the best work on the part of the tanks. The sludge had to be pushed down the conical bottom of the tank once in two or three days, by means of a heavy weight attached to a rope. The lower plates of the bottom of the tank overlapped the upper, forming ledges which doubtless retarded the flow of the sludge.

The composition and cost of the various chemicals are shown in Table III.

TABLE III.—Composition and Cost of Chemicals used in Precipitation.*

Sulphate of Alumina.**	
(From Robert Stevenson & Co., Chicago.)	
Cost, in barrels, per ton	$47.00
Insoluble in water, %	.06
Alumina	15.64
Ferric oxide	.50
Sulphuric acid	34.88
Moisture and undetermined	48.92
Sulphate of Alumina.**	
(From Merrimac Chemical Company, Boston.)	
Cost, in bulk, per ton	$20.40
Insoluble in water, %	6.11
Alumina	13.17
Ferric oxide	1.31
Sulphuric acid	32.66
Moisture and undetermined	46.75

*The cost includes freight to Jackson Park in each case.

**Taking into account the difference in analyses, the first sample was twice as expensive as the second.

Copperas.

(From Washburn & Moen, Waukegan, Ill.)

Cost, in bulk, per ton	$13.40
Insoluble in water, %	0.24
Ferrous oxide	25.21
Sulphuric acid	28.50
Moisture and undetermined	46.05

Crude Ferric Sulphate.

(From Jobbins & Van Rymbecke, Aurora, Ill.)

Cost, in barrels, per ton	$32.00
Insoluble in water, %	12.00
Ferric oxide	22.76
Sulphuric acid	45.00
Moisture and undetermined	20.24

Lime.*

(From Chicago Union Lime Company.)

Cost, in barrels (60 cts. 200 lbs.) per ton	$6.00
Insoluble in acid, %	0.10
Alumina and ferric oxide	1.00
Calcium oxide	57.10
Magnesium oxide	38.60
Water, carbonic acid and undetermined	3.20
Lime soluble in water	55.01

(From Hannibal Lime Co., Hannibal, Mo.)

Cost, in barrels (75 cts. about 175 lbs.) per ton	$8.80
Cost, in bulk, 22 cts. per bu.	6.50
Alumina and ferric oxide, %	1.50
Calcium oxide	95.00
Water, carbonic acid and undetermined	3.50
Lime soluble in water	93.00

The cost of constructing the sewage purification works was about $55,000, of which more than $20,000 was for the building. The approximate cost of operation from April 14 to Oct. 27 was as follows, the figures not including the cost of superintendence or analyses, or of burning the sludge, and the costs per units in the last four lines having been added for convenience:

Cost of chemicals	$3,567
Labor applying chemicals	1,357
Total cost of precipitation	$4,924
Cost of fuel oil	2,612
Labor on engine and presses	6,671
Total cost of pressing	$9,283
Total cost of operation	14,207
Million gallons sewage treated	373
Tons sludge cake pressed	1,284
Cost precipitation, per million gallons	$13.20
Cost pressing sludge, " "	24.89
Total cost, per million gallons	$38.09
Cost pressing sludge, per ton pressed	7.23

A large number of tables are presented in the paper, showing in more detail than has been indicated the operation of the works, but it is believed that the points of most interest and value have been presented above. Mr. Hazen summarizes the results obtained by the works as follows:

In an experimental way the sewage cleansing works of the World's Columbian Exposition have served to indicate some of the peculiarities of the form of settling-tank used, and have clearly defined some forms of construction which should not be repeated.

In a practical way they succeeded in holding back from Lake Michigan 1,300 tons of sludge removed from the sewage treated, and containing 250 tons of actual organic matters. They prevented the sewage from making a nuisance along the lake front such as often resulted from one of the city's sewers discharging untreated sewage just north of the grounds, and they reduced the danger of infection of the water drawn from the Hyde Park intake and supplied to the fair grounds and to the southern part of the city of Chicago.

As an object lesson to thousands of visitors they have given new ideas as to the possibility and necessity of sewage treatment and as to modern methods of securing the cleanliness of the waters on which many cities and towns are located.

Sewers and other obstructions in the way of a railway tunnel under Broadway were the subject of a report to the New York Rapid Transit Commission at its last meeting, by Chief Engineer W. B. Parsons and Mr. Horace Loomis, Engineer in Charge of the New York Sewer Department. The report stated that in the distance of 12,630 ft. from the Battery to 14th St., there are 7,830 ft. of longitudinal sewers, and 18 sewers which either cross or connect with these. To readjust these for the construction of an underground road would require the building of 24,935 ft. of new sewers in Broadway, 12,930 ft. in the side streets and 5,760 ft. in Canal St. and its connections, or 43,625 ft. altogether. On the 23d St. route, from 14th St. down, or 13,000 ft., 29,110 ft. of new sewers would be required. On the 9,873 ft. of the University Place route, 19,087 ft. of sewers would be required. Mr. Parsons is consulting with Mr. Theodore Cooper and Mr. Alphonse Fteley with regard to the difficulties likely to be met with in building upon each of the proposed routes.

* Even at the higher price paid for the Hannibal lime, it was a much more economical lime to use, on account of the much higher percentage of available lime. The magnesia present in the local lime is without value in sewage treatment; it simply adds itself to the sludge.

DIAGRAM FOR PROPORTIONING RIVETED CONNECTIONS IN STRUCTURAL WORK.

The accompanying sketch illustrates a diagram for bridge draftsmen's use in laying out rivets in tension member connections or plate girder flange splices. The diagram is plotted for ¾-in. rivets, and on the assumptions that the strength of a rivet in single shear equals one-half the tensile strength,

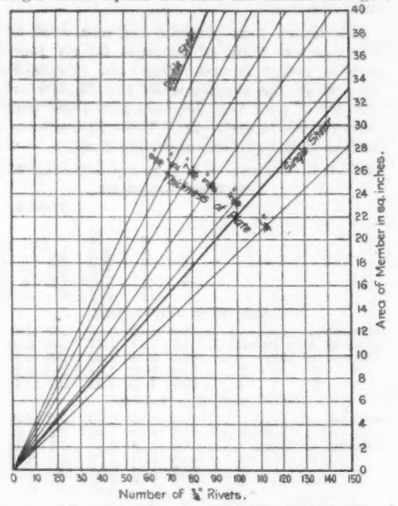


Diagram Showing Number of Rivets to be Used with Various Cross Sections of Tension Members.

and that its strength in double shear and the resistance of the plate to crushing are equal to the tensile strength of the section. Of course diagrams for rivets of other diameters or for other assumptions can be readily plotted in the same way. Mr. E. S. Mattice, B. A. Sc., who sends us the diagram, states that he has found it to save much labor in designing iron work. Mr. Mattice is connected with the Dominion Bridge Co., of Montreal.

TESTS OF IRON CUT FROM OLD BRIDGES.

The following is an abstract of a report on tests of materials taken from an iron girder bridge near Loewen, which we find in "Den Tekniske Forenings Tidsskrift." The report opens by referring to the increased frequency with which tests of material that has stood actual service are called for nowadays. This requirement has come into vogue in several European countries since the fall of the railway bridge at Monchenstein (Eng. News, Aug. 1, 1891). In cases where repairs are found necessary or strengthening is to be done, it is an easy matter to procure such test pieces, and they are selected from places where the material is supposed to have been subjected to the greatest and most variable amount of stress, and, for the sake of comparison, also, from a part of the structure where there is no stress at all.

The bridge referred to is 38 years old. The material at the center is subjected to strains varying from 7.8 to 8.5 kg. per sq. mm. (11,094 to 12,090 lbs. per sq. in.), while the strain at the ends is zero. The following table shows the ultimate resistance offered by material taken from the middle and from the end:

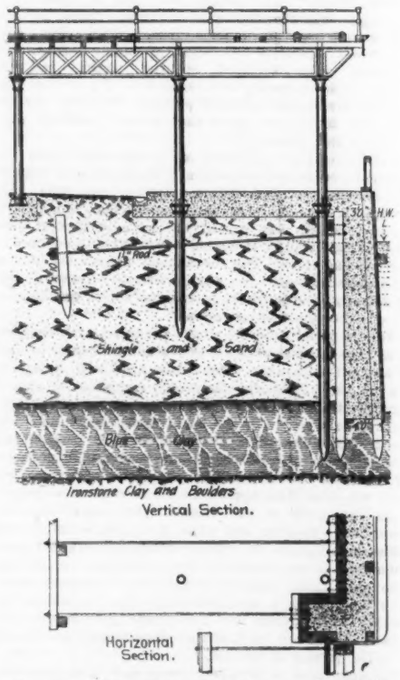
Tensile strength..	End: 32.1 to 35.6 kg. per.. mm., 45,656 to 50,634 lbs. per sq. in. Center: 32.6 to 35.3 kg. per sq. mm., 46,367 to 50,207 lbs. per sq. in.	Difference varying from 1.6 to 2.6%.
Elongation.....	End: 11.0 to 24.0%.....	Difference varying from 3.0 to 6.0%.
	Center: 13.5 to 25.0%	
Contraction.....	End: 15.5 to 33.3%.....	Difference varying from 4.2 to 10.6%.
	Center: 19.8 to 32.0%	

There was thus a very small difference in the strength of the materials taken from similar parts of the structure, but subjected either to stresses of great range or to no stress at all. The difference is, indeed, not larger than it might have been at the time of erecting the bridge. In the case of elongation, the difference is more marked, but as it appeared to be greatest in the beginning of both tests, it might have been inherent in the material from the beginning. As an average of these results, it appears that the material taken from the middle showed 0.13 kg. (184.9 lbs. per sq. in.) greater tensile resistance, 0.97% greater elongation and 1.41% greater reduction of area than in the case of the test pieces taken from the end. The fractures were all satisfactory, and the material was well preserved against rust. A similar inspection has been made of a bridge on the line of the Cologne-Herbesthal Ry., which has been in use since 1839 and was strengthened in 1886. In this case also it was not proved that the material had in any way depreciated in strength or resilience.

THE CONSTRUCTION OF A CONCRETE WHARF AT PORTSLADE.*

When the Brighton & Hove General Gas Company's Works, at Portslade, were constructed in 1870, a single timber wharf was sufficient for the requirements of the works. To accommodate, however, the increased business of the company, it was found necessary, in 1889, to construct a second wharf. The action of marine insects upon the wooden piles forming the original wharf suggested the use of a more durable material for the new structure, and concrete was selected.

Owing to the natural level of the land-water being about 6 ft. below the ground-line, and the subsoil being beach and sand of a treacherous character, running freely wherever its section became exposed, it was decided to form a timber frame of piles to receive the concrete. Accordingly a line of sheet-piles, 12 × 12 ins. and 26 ft. long, was driven, and these piles were secured vertically by walings and iron ties to a line of back piles. The accompanying cut shows horizontal and vertical sections of the work. The bank of the canal was then partly removed by dredging, and the front of the wharf was formed by a line of 12 × 12-in. piles, each 28 ft. long (driven at an angle of 87°) and 7 ft. 6 in. c. to c. The consent of the



Concrete Wharf Construction at Portslade, England.

Shoreham Harbor Trustees having previously been obtained for the lock-gates to remain open, the canal became tidal for a series of tides; eight days were given in which the wall had to be built to high-water line, and about two hours during each tide were available for the work. As the water-level in the canal fell, the excavation of the shingle between the sheeting-piles and the front piles was commenced; and after the level of the foundation of the wall was reached, the face of the front piles was covered by battens, 7 × 2 ins., and the frame so formed was filled with concrete. When the work was stopped by the rising tide, the concrete was covered by boards weighted down;

* By Joseph Cash, M. Inst. C. E., from selected papers of the Institution of Civil Engineers.

and when work was resumed, any concrete not properly set was removed, and cement grout was spread on the surface before the next layer was commenced. The height of wall constructed during one tide varied from 1 ft. 6 ins. at the commencement of the work to 3 ft. 6 ins. as the wall rose above the influence of the tides. When the wall was completed, the front of the wharf was dredged level until a depth of 17 ft. at ordinary spring-tide was reached; that being the depth of the water in the channel of the canal along which vessels have to pass to the wharf.

The piles were of pitch-pine, creosoted and shod with cast iron shoes. The cast iron piles for supporting the viaduct and cranes are in two rows. The piles in the front line were cast in two pieces, the upper pieces being socketed in the lower after the latter had been driven, Fig. 1. They were all driven without fracture by a 17-cwt. monkey falling 3 ft. on a lead dolly fitted in and over the heads of the piles. The sets produced by the final blow on the 26-ft. piles in front varied between 1-16 in. and ⅛ in. The concrete was gaged, for the lower part of the wall, 1 part of Portland cement to 2 parts of sharp sea sand to 3 parts of beach gravel; and for the upper part of the wall, 1 part of Portland cement to 2 parts of sharp sea sand to 5 parts of beach gravel.

In 1890 the original timber wharf was replaced by a concrete wall constructed on the same principle, and the intervening space between the two wharves was filled with piles with a low concrete wall at their base, forming a residual wharf. As completed, the company has wharfage accommodation 450 ft. in length, giving facilities for the discharge of two steamers simultaneously, as well as space for the discharge of fire goods, etc., and the shipment of coke, tar, and other residual products. Over the wharves are iron viaducts with steam-cranes capable of discharging 35 tons of coal per hour in loads of 10 cwt. The coal is then taken in small trucks along the viaducts to the retort-houses or coal stores.

THE MAXIMUM PRACTICABLE LENGTH FOR SUSPENSION BRIDGES.

The board of officers of the Corps of Engineers, U. S. A., whose names are appended to the following report, was ordered by the Secretary of War on Jan. 20, 1894, to investigate certain bridges. The Secretary says that in view of the importance of questions arising in the Department in connection with the building of bridges over navigable streams, it is essential that the Department should be possessed of accurate and full information necessary to their intelligent and proper determination. He, therefore, directed this board to investigate and report "their conclusions as to the maximum length of span practicable for suspension bridges, and consistent with an amount of traffic probably sufficient to warrant the expense of construction." To these instructions the Chief of Engineers, General Casey, added the further instructions to include in the investigation "strength of materials, loads, foundations, wind pressure, oscillation and bracing."

This investigation is novel in its character and the thoroughness of its treatment by a most able board of engineers makes the report one of the most interesting and instructive of engineering documents. It is so valuable that it is given in full, excepting only the five appendices named at the end of the report. The report itself is made to Brig.-Gen. Thomas L. Casey, Chief of Engineers, U. S. A., and is as follows, omitting only an introductory statement, the substance of which we have given above:

The Board convened at New York city on Feb. 13, 1894, and remained in session until Feb. 15, 1894, when it adjourned to collect information. The Board held a session at Philadelphia, Pa., from March 6 to 10, 1894. An extended preliminary investigation of the subject under consideration had already been made when a Board of expert bridge engineers was appointed by the President, on June 15, 1894, under the provisions of the act approved June 7, 1894, to recommend what length of span, not less than 2,000 ft., would be safe and practicable for a railroad bridge to be constructed across the Hudson River between New York city and the state of New Jersey. The New York Board was composed of five engineers, four of whom were civil engineers of long and varied experience in the designing and construction of bridges and of the highest professional standing. It was therefore considered desirable to delay the completion of this report until the determinations of the New York Board could be ascertained and studied. The present Board has derived much assistance from the published report of the New York Board, as will be indicated below. At the last session, which was held at Philadelphia from Sept. 20 to Sept. 29, 1894, this report was unanimously adopted.

The question of the maximum practicable span may be investigated as a purely engineering problem, when certain preliminary conditions are established. The bridge will doubtless be a railroad bridge, since with the largest span the traffic capacity would not otherwise justify the cost. This assumed, the width must be at least sufficient to accommodate a double track. The number of double tracks required must be established so as to give a traffic capacity "probably sufficient to warrant the expense of construction."

The New York and Brooklyn bridge, the longest suspension bridge yet constructed, consists in reality of two similar bridges suspended side by side and braced together, the promenade being supported between the bridges as an extra weight on the interior cables. Following this idea, the Board in its preliminary investigation assumed a double-track railroad bridge as the unit bridge, bracing together side by side as many such bridges as were considered necessary to accommodate the traffic contemplated. The engineering problem was thus limited to the question of determining the maximum span for a double-track railroad bridge. It was found, however, that there are many serious practical objections to such an arrangement in a long-span bridge carrying very heavy loads. In this investigation, therefore, the loads will be assumed to be supported by only two sets of cables, one on each side of the bridge; an arrangement which was adopted as a basis of estimate by the New York Board.

In the various projects for long-span bridges across the Hudson River at New York the least traffic capacity assumed was six tracks, and the New York Board adopted this number of tracks in its investigations. In this report, therefore, it is proposed to first consider the question of the maximum span for a six-track railway bridge as an engineering problem, after which the relations between span, traffic and cost of construction will receive such investigation as the nature of the subject will permit. Since much of the information with reference to strength of materials, loads, etc., collected by the Board as directed by the Chief of Engineers is necessary for the proper investigation of the question of the practical maximum span, this part of the subject will first receive attention.

Strength of Materials.

The supporting cables of a suspension bridge of long span are made of steel. They are either chains composed of connected links or cables formed of parallel wires or twisted wire ropes. To obtain the longest span possible the weight of the cable must be a minimum as compared with its carrying capacity. The connections of a series of links add from 20 to 25% to the dead weight of the chain, while in the wire cable the connections add, at most, only 2 or 3%. Moreover steel in the form of wire has a minimum strength more than double its maximum strength in the form of bars suitable for the construction of a suspension chain. A link chain, therefore, will weigh about 2½ times as much as a wire cable of equal carrying capacity; or in other words, a wire cable can be stretched about 2½ times as far as a steel chain before being broken, other conditions being the same in both cases. Moreover, it is stated by Melan* that considerable bending moments are sometimes produced by the friction between the links of chains, but the effects due to the stiffness of cables are so small that they may be neglected. It is therefore assumed that the cables are made of steel wires laid parallel to each other.

The strength of the suspension cable will depend upon the tensile strength of the steel employed in its construction and upon the number of wires it contains. The wire employed in the cables of the New York and Brooklyn bridge had a tensile strength of 170,000 lbs. per sq. in., and the cables were originally designed to contain each 6,188 wires of No. 7, B. W. G., but as some heavier wires were introduced during construction, the actual number of wires was only 5,400. These are the largest cables made up to the present time, having a diameter of 15⅝ ins. The cables of the Cincinnati suspension bridge have a diameter of 12 ins., and each contains 5,200 No. 9 wires.

There is a practical limit to the number of wires which can be united in a cable, since as the number increases it becomes more and more difficult to adjust the wires so that each will bear its due proportion of stress under the varying conditions of temperature and loading. No unusual difficulties, however, were encountered in the manufacture of the cables above referred to, but it is believed that with the method employed for making the cables of the East River bridge the practical limit of the number of wires was very nearly, if not quite, attained. With improved methods the construction of much larger cables might be found practicable. An increase in the size of the wire does not materially increase the difficulty of construction. No. 3 wire having a tensile strength of 180,000 lbs. per square inch, can now be readily obtained at a reasonable price. Indeed steel wire much stronger than this can be obtained (up to more than 300,000 lbs. per square inch) but its present cost would prohibit its employment.

*Handbuch der Ingenieurwissenschaften. Band II. Der Brueckenbau—J. Melan, Leipzig, 1888.

The Board therefore assumes for the purposes of this investigation a suspension cable formed of 6,000 parallel steel wires, No. 3, B. W. G. The area of its cross-section will be 316 sq. ins. without wrapping, and its breaking tensile strength will be 56,880,000 lbs., or 28,440 tons. With a safety factor of 3, which was adopted by the New York Board, and will be adopted in this investigation for reasons to be given hereafter, the working strength of this cable will be 18,960,000 lbs., or 9,480 tons. Its diameter with wrappings will be 21½ ins. The New York Board have adopted a cable of about this size and strength in their estimates.

The total cable strength available for the support of the bridge depends upon the number of cables which can be practically combined as a single cable system on one side of the bridge. If many cables are employed it becomes difficult to distribute the strains among them so that each shall carry its proportionate load under the varying conditions of temperature and traffic. It is not easy to decide what is the practical limit of the number of cables to be assembled together. Where parallel wire cables are used they must be sufficiently separated horizontally and vertically to give room for the operation of the wire wrapping machine, and this requires intervals of at least 3 feet during construction.

The cables may cross the saddles on top of the towers side by side, or they may be arranged in one or more vertical, or nearly vertical, planes. In the first case the cradling of the cables in converging planes (which is desirable for lateral stability) requires considerable intervals between the saddles. In the investigations of the New York Board an interval of 20 ft. was found to be necessary for such an arrangement. But the cables on one side of the bridge may also be arranged side by side in parallel inclined planes, and held the same distance apart throughout their length by iron separators between the suspender clamps, in which case the saddles on the towers would be closer together. Still the number of cables suspended on each side cannot be made very large without increasing the dimensions of the towers and the piers supporting them far beyond the requirements of the roadway and suspended loads.

The vertical arrangement of the cables (or a combination of vertical and horizontal arrangements) certainly presents some very decided advantages. It requires less width at the top of the towers, and a large part of the stiffening of the bridge may be obtained by trussing the cables in a manner which will be again referred to. Moreover, with this arrangement the towers can be so constructed that new cables can be readily added to meet future demands for increased traffic capacity. This method, however, is not so simple as the other, and with large loads and cables involves mechanical difficulties which can be properly dealt with only after an extended investigation of the problem as a special case. In this general investigation the Board consider it best to adopt the simpler arrangement, as has been done by the New York Board. Whatever arrangement is adopted, the Board are of the opinion that it would not be found convenient to work more than eight cables together as one cable system. For the purposes of this investigation, it is therefore assumed that the suspension bridge of maximum span is supported by 16 21½-in. cables. The following list giving the arrangements employed in a number of important bridges, may be of interest in this connection:

New York & Brooklyn Bridge, 1,595.5 ft. span, has one 15⅝-in. cable on each side.

Niagara Bridge, 821.3 ft. span, two 10-in. cables, one vertically over the other.

Wheeling Bridge, 1,010 ft. span, two 8-in. cables, side by side.

Fairmount Bridge, 550 ft. span, seven cables, 6 side by side and 1 above.

Freiberg Bridge, Switzerland, 870 ft. span, three cables, 2 side by side and 1 above.

Dordogne Bridge, France, 350 ft. span, three cables, side by side.

Niagara Bridge, at Lewiston, 1,400 ft. span, had four cables side by side.

Menai Bridge, 600 ft. span, four chains in the same vertical plane.

Tweed Bridge, Berwick, 450 ft. span, three chains in the same vertical plane.

Tersing Bridge, over the Maas, two chains, one over the other.

Bridge Voconflans, St. Honorine, two chains, one over the other.

La Roche Bernard Bridge, over the Vilaine, 650 ft. span, two cables, side by side.

Lambeth Bridge, England, two cables, side by side.

Donau Bridge, Pesth, 900 ft. span, two chains, one over the other.

Moldau Bridge, Prague, four chains in pairs over each other

Loads.

The total load supported by the bridge will consist of two parts, viz., the live load or weight of the passing traffic and the dead load or weight of the structure. It

will be convenient to consider the load under these two heads.

1. Live Load.—In another part of this report the difference in the character of the action of the live load upon a structure in stable equilibrium having a certain degree of flexibility from that of its action upon a more rigid structure in unstable equilibrium will receive due consideration. For the present we will only determine the magnitude of the live load. The live load per linear foot of span will be represented by q. The greatest static effect upon the cable will be produced by the maximum load; that is, when the whole platform from tower to tower is covered with the heaviest possible railroad trains. A suspension railroad bridge of very long span will as a rule be built only over a wide river or estuary navigable by ocean craft and therefore requiring a great height of the bridge above the water. To limit the expense of the shore extensions the approaches must be given as steep a grade as is admissible for a railroad bridge. It is, therefore, assumed that the approaches will have a grade of 1%.

The weight of a railroad train passing over the bridge need not be considered as any greater than that which the heaviest freight locomotive is capable of hauling up a 1% grade. From a list published by the Baldwin Locomotive Works it appears that exceptionally heavy locomotives are built with 170,000 lbs. on the drivers and a total weight of 192,500 lbs. The Baldwin Works allow 9 tons for each 1,000 lbs. on the drivers as the maximum efficiency on a grade of 1%. This extra heavy locomotive can therefore pull up on the bridge 1,530 tons, including its own weight. Subtracting 96 tons for the weight of the locomotive, we have for the weight of the train 1,434 tons. This is equal to 41 hopper-bottom gondola cars, each 27 ft. 2 ins. long and weighing 35 tons. The length of the engine and tender being 54 ft., the total length of the train will be 1,168 ft., and the weight per linear foot of track will be 2,620 lbs., equal to 1.31 tons. If we suppose all 6 tracks to be loaded from end to end with such trains, the live load per linear foot will be 15,720 lbs., equal to 7.86 tons.

Any such loading as this, however, is so extremely improbable as to be a practical impossibility; indeed, at the height above water level at which such a bridge must be carried, the transportation of passengers, and not of freight, must be the main consideration. A purely freight traffic would in no conceivable location require six tracks over a bridge of very long span. Such a number of tracks would only be justified by the location of the bridge near a very large city and by a large passenger traffic. The trains passing over such a bridge would undoubtedly be controlled on the block system, and not more than one train on each track would be allowed upon the bridge at the same time. If the stiffening girders could do their full duty the weights upon the bridge would be uniformly distributed and the live load per linear foot would be $\frac{3,060,000}{L} \times 6 = \frac{18,360,000}{L}$ lbs. The distribution, however, is not perfectly uniform, and there are occasionally other causes which produce an increase in local stresses. The Board consider its best to add 50% to this estimate to cover these uncertainties. In computing the cable strength, therefore, the adopted value of the live load will be:

$$q = \frac{27,540,000}{L}.$$

The live load assumed for the Niagara Suspension Bridge, which has a span of 800 ft., is 350 tons in a length of 450 ft. of single track, which is equivalent to 1,600 lbs. per lin. ft. of train, or less than 1,000 lbs. per lin. ft. of the entire span, with a factor of safety of 4.41 in the cables and 4.0 in the stiffening girders.* The bridge, however, safely carries heavier trains in daily operation. The largest existing railroad bridge is the Forth Bridge, in Scotland. It has 2 tracks and 2 spans of 1,700 ft. each. It was tested with 2 heavy trains side by side, each 1,000 ft. long and weighing 900 tons. Each train was drawn by 2 locomotives, each weighing 72 tons. This load was equivalent to 1,800 lbs. per lin. ft. of track, or 3,600 lbs. per lin. ft. of span. These were considered extra heavy train loads very seldom occurring in actual operation on English roads.**

Making allowance for the heavier train loads of American railroads, it will be seen that 3,000 lbs. per lin. ft. of track for a length of 1,500 ft., considered as distributed over the bridge from tower to tower (which is the value given by our formula), is an exceedingly safe assumption of the live load for a very long bridge in which the span exceeds the length of the maximum train. This value agrees very nearly with that assumed by the New York Board in its estimate for a "lighter structure."

It is very evident that the assumed live load per unit of track ought to diminish with the number of tracks and with the length of span. A single-track bridge of short span is strained nearly to its maximum every time a train goes over it. A six-track bridge is strained to its maximum only when six maximum trains are abreast of each other; and when the span exceeds the maximum train length the maximum stress ought never to occur.

2. Dead Load.—This produces at all times constant strains in the members of the bridge. It is composed of the weights of the following parts: The suspension cables with their wrapping, the platform, the stiffening girders, the wind and sway bracing and the suspenders. The weights of these parts per linear foot of span will be represented as follows: Cables = w; cable wrapping = w_0; platform = p_1; girders = p_2; bracing = p_3; suspenders = p_4.

(1) Weight of the Suspension Cables.—The weight of a cable formed of 6,000 parallel steel wires, No. 3, B. W. G., having a diameter of 21¼ ins., without wrapping, will be 1,075 lbs., or 0.538 ton per running foot. If we assume 16 cables for the support of the entire bridge, the total cable weight per linear foot will be $w' = 17,200$ lbs. = 8.6 tons; and $w = 17,917 = 8.959$ tons.

(2) Cable Wrapping.—The cable will be wrapped with iron wire of No. 9, B. W. G. The weight of this wrapping will be 26 lbs. per lin. ft., and for 16 cables, 416 lbs. The weight of wrapping per linear foot of span will therefore be $w_0 = 433$ lbs.

It will be found convenient for the purposes of this investigation to know the relation between the weight of the cable per linear foot of horizontal span (w) and its weight per foot measured in the direction of its axis (w'). The cable curve will be approximately a parabola, and its approximate length will be $\left(1 + \frac{2.67}{R^2}\right)$ L, in which L is the horizontal span in feet and R is the ratio of the versine of the cable to the span. Hence $W = \left(1 + \frac{2.67}{R^2}\right) w'$. For reasons which will be given in the sequel the value of R will be assumed as 8 in this investigation. For this value we have $w = 1.0417\ w'$ and $w' = 0.960\ w$.

(3) Weight of the platform.—In the arrangement adopted in this investigation for the purposes of estimate the cross-girders sustain the weight not only of the live load but also of the stiffening girders and lateral bracing. The distance between the cross-girders is 30 ft. The platform further consists of longitudinal girders (stringers), the permanent way consisting of ties and rails and the covering. Its construction is the same as in any other railroad bridge.

The weights of the stiffening girders and lateral bracing (which increase with the span) are imposed upon the cross-girders so very near the points of suspension that the weight of the platform may be considered practically independent of the span. The weight per linear foot of span for a 6-track platform, carrying stiffening girders and bracing, for a span of 3,200 feet, was determined by the New York Board to be 7,200 pounds. We may therefore adopt in this investigation the constant value $p_1 = 7,200$ pounds = 3.6 tons.

(4) Weight of the stiffening girders.—It will be shown under the head of Vertical Bracing that the weight of the two stiffening girders per linear foot of 6-track bridge may be found in pounds from the formula $p_2 = 3,281 + 2.754\ L + 0.0005312\ L^2$. This includes an allowance of material in the lower chords to provide for the stresses due to wind.

(5) Weight of the lateral bracing.—As will be shown under the head of Lateral Bracing, the weight of the wind and sway bracing per linear foot of 6-track bridge (so far as not provided for in the preceding paragraph) will be given in pounds by the formula $p_3 = 2,240 + 0.3889\ L$.

(6) Weight of the suspenders.—The suspended load is connected with the cables by 8 wire suspenders on each side of the bridge at each cross-girder. The suspenders at each girder are equal in length, and are supposed to be adjusted so as to carry practically equal portions of the load. At the middle of the span the cables are 60 feet above the level of the suspension pins. The versine of the cable being $\frac{L}{8}$ the average length of a suspender is $\frac{L}{24} + 60$. Assuming a unit working stress of 30,000 pounds and adding 20 per cent. for constructive details, the weight of the suspenders per linear foot of span will be

$$p_4 = \frac{3.4 \times 1.2}{30,000}\left(\frac{L}{24} + 60\right)(p' - w_0)$$

in which $p' = q + p_1 + p_2 + p_3 + p_4 + w_0$.

For the purposes of this computation we may assume $p_4 = 1,300$ in the value of $p' - w_0$.

From values previously given we find $p' - w_0 = 14200 + 2754000\ L^{-1} + 3.1429\ L + 0.0005312\ L^2$; and $p_4 = 272 + 224726\ L^{-1} + 0.10616\ L + 0.00002215\ L^2 + 0.000000003\ L^3$.

(7) Total suspended weight.—The total suspended weight per linear foot of span exclusive of the cables will be $p' = q + p_1 + p_2 + p_3 + p_4 + w_0 = 13605 + 27764726\ L^{-1} + 3.24906\ L + 0.00055335\ L^2 + 0.000000003\ L^3$.

Wind Pressures.

The wind pressure upon a large bridge is of such magnitude as to require especial consideration. In the principal members of the Forth Bridge (a cantilever construction) the maximum stresses due to wind have been stated by its engineer to be more than one-quarter greater than those due to the dead weight of the bridge, and nearly three times as great as those due to the live load of passing trains. In suspension bridges these wind stresses, though they may be less than in other bridges, are still of very great importance, and must be carefully provided against by the introduction of metal which, while adding nothing to the carrying capacity of the bridge, does add considerably to its dead load, and therefore necessitates an increase in the strength of suspenders, main cables, towers, anchorages and foundations, and thus may add enormously to the total cost of the bridge. Under such circumstances, while it is, on the one hand, important to secure a sufficiency of wind bracing, it is, on the other hand, equally important not to use any more than is actually necessary. Since the existing fund of information as to wind pressures, as to their effect on bridges, and as to the present most used methods of dimensioning wind bracing, is either quite limited or else is not easily accessible, it has been thought well to attach hereto a full history of past work in this direction, with suggestions of rules for use in the dimensioning of large structures in places exposed to heavy winds. (See Appendix C.)

Past history shows the possibility, at almost any place, of an occasional tornado of power sufficient to destroy almost any existing engineering structure. Such tornadoes, like violent earthquakes, are so rare that no large constructions of to-day are made thoroughly proof against them. In such a tornado, however, a suspension bridge would fare much better than any other form of bridge, as it offers the least surface to the wind, as its overturning is almost a physical impossibility, and especially as the loss of large parts of its roadway and stiffening trusses would not necessarily destroy its main cables and towers (these being its essential and costly features). The Board have therefore (for reasons stated in the Appendix) considered a maximum steady wind pressure of 30 lbs. per square foot over the entire structure and over a continuous train, reaching entirely across the bridge, and also a similar 30-lb. pressure over the unloaded bridge, accompanied by an added pressure of 20 lbs. per square foot (making 50 lbs. in all) over 1,000 ft. of the unloaded bridge; this latter allowance being made to provide for occasional severe gusts.

The exposed surface of the bridge and load per running foot (by the method of calculation given in full in the Appendix) is taken at 30 sq. ft. for the cables and suspenders, 49 sq. ft. for the stiffening girder (including the upper chord, lower chord, web members, horizontal diagonals, and sway bracing), 18 sq. ft. for the platform (including track, guard rails, ties, cross girders, and stringers), and 8 sq. ft. for the train (excluding the portion sheltered by the high bottom chords and other adjacent parts of the stiffening girders). In view of the heavy weights and consequent great inertia of the cables and stiffening girders, the resulting wind pressure is treated as uniformly distributed over the entire bridge from end to end; though a more careful distribution, perhaps saving considerable metal, would be adopted in actual practice. The cradling of the main cables and suspenders is considered sufficient to amply resist the 1,050 lbs. per square foot of wind pressure due to the 30 sq. ft. per linear foot of their own surfaces. The wind bracing of the stiffening truss will then have to resist only the wind pressure on the stiffening truss, platform, and train; which amounts to 2,345 lbs. per linear foot for the unloaded bridge, and 2,250 lbs. per foot for the loaded bridge.

As the stiffening truss is hinged at its middle, the wind bracing (at least near the ends of the half trusses) must be arranged to carry all the wind stresses to the bottom chord; so that this bracing is taken as composed of a very light upper horizontal truss (not theoretically necessary), of a strong vertical sway bracing, and of a heavier lower horizontal truss. Since the wind trussing may be combined with the adjacent parts of the stiffening girder and platform, this lower wind truss will be built up by increasing, where necessary, the dimensions of the cross girders of the platform, and the lower chords of the stiffening truss, and by inserting cross diagonals between them.

Because of the great size of these cross girders and lower chords, and therefore the great excess of strength in this lower truss when the bridge is unloaded, the Board regard the 2,250 lbs. per linear foot of wind pressure on the loaded bridge as the one which throws the greatest strain upon its members, and, therefore, take this value as the one to be used in combination with the other loads upon a bridge of maximum length. In case further lateral stiffness against wind should, at any time, be thought desirable it may be obtained by the use of horizontal wind

*Proceedings Am. Soc. C. E., vol. X., p. 195.
**Record of the Forth Bridge, p. 64.

cables under the platform; and small main cables may at any time be added, if found necessary, to support the added weight of such wind cables; but the Board consider the use of such wind cables unnecessary.

Oscillations.

In considering the character and importance of small motions in bridges, it is necessary to distinguish carefully between stability and rigidity. A suspension bridge is the most stable of all bridge structures. The locus of the centers of gravity of its vertical cross-sections lies far below the points of support. The live load, which is the main cause of its vertical oscillations, always moves below the gravity line, thereby increasing the lateral stability of the structure. As the span is increased the gravity line rises, but the resulting slight decrease in stability is more than compensated for by the diminution in the ratio of the live to the permanent load. The small motions of erect-arch and deck bridges must be carefully confined within small limits to insure the safety of the structures, but there is no such necessity in the case of suspension bridges, where the system is in stable equilibrium and sure to return to its position of rest whatever may be the magnitude of the displacement. The lateral oscillations are due mainly to the action of the wind. These are met not only by the great weight of the structure, but also by the cradling of the cables, which much increases the lateral stability.

It is possible to construct a suspension bridge so that it will have any degree of rigidity desired, but it will appear from the above that rigidity is in this case of much less importance than it is in most other kinds of bridges; indeed, it may be shown that a certain small flexibility is a positive advantage in suspension bridges.

The Board do not consider it necessary to give in this report an elaborate development of the theory of bridge oscillations, because it is perfectly easy to stiffen a suspension bridge so as to reduce both its vertical and lateral deflections, and consequently the duration of its oscillations, within any desired limits; and in bridges of very long span, where the ratio of live to dead load is comparatively small, no difficulty from this cause need be anticipated. The following brief remarks on this subject relate to suspension bridges of comparatively small weight and span.

As before remarked, oscillations in suspension bridges are mainly produced by the impulses of the moving load and by the pressure of the wind. The magnitude of the oscillations is sometimes increased by the lengthening of the central part of the cable, due to the straightening of the chains of the side span under the action of a load on the central span. Theoretically an infinitely small impulsive force may produce an infinitely small amplitude of oscillation of finite duration. If such impulses are repeated a summation of their effects may result. This will occur when the interval between two impulses is equal to the time of oscillation, and may occur when it is greater. Under these circumstances small impulsive forces, by many repetitions, may produce a great oscillation in an elastic or suspended body. In this way the wind has been known to raise waves in the platform of a light suspension bridge.

In the case of a bridge truss it is important that the time of oscillation produced by a load acting impulsively should not exceed a certain amount, in order that the oscillations may not be cumulative. In highway bridges it is especially the measured step of pedestrians which gradually augments the amplitude of the oscillation when the time of oscillation is equal to or greater than the time of a step, which may be assumed as from 0.6 to 0.7 second. If the time of oscillation of the structure is greater, it can adjust itself to the time of a step by the formation of centers of oscillation. The result is that by the gradual accumulation of energy changes of form are produced which are considerably greater than those produced by an equivalent static load.

These oscillations occur not only in elastic or stiffened systems, but also in slack systems. A freely suspended heavy chain moved from the position of equilibrium in its vertical plane will assume oscillating motions which will gradually increase if new impulses occur in the time intervals corresponding to the time of oscillation or a fraction thereof. It is shown by Melan that the time of oscillation of a slack chain is materially greater than that of even a very elastic construction, which explains the well-known fact that unstiffened suspension bridges can very easily be brought into great oscillations by a few pedestrians.

Prof. Melan in his treatise on Bridge Construction deduces the equations $t = 1.806 \sqrt{f}$ and $t = 2.0063 \sqrt{u + 0.8\, u_0}$ for the times of oscillation in a slack and a stiffened system, respectively; in which t is the time of oscillation in seconds, f is the versine of the cable in meters, u_0 is the deflection in the middle due to the uniformly distributed dead load, and u is the increase of deflection due to a concentrated load in the position of rest in meters.

From these formulas it follows that the time of oscillation of a bridge structure depends only upon the magnitude of its deflection in the position of rest, no matter what may be the character or size of the structure. Hence the deflection must be kept within certain limits, in order that the bridge may not be set in vibration by the steps of pedestrians or other regularly repeated impulses. The time of oscillation, and consequently the deflection, must be the smaller the more rapidly the repetition of impulses occurs. Hence greater stiffness is required in a railroad suspension bridge than in a similar highway bridge.

As the deflection u_0 due to the uniformly distributed load is in general proportional to the fourth power of the span, it follows that the time of oscillation varies approximately as the square of the span. Therefore, this time may be diminished by fastening the structure at intermediate points to the shore or ground, so as to form a number of centers of oscillation.

The occurrence of cumulative oscillations may also be prevented by employing together several systems for stiffening the cables, these systems having different periods of oscillation; and where a number of cables are assembled on each side of the bridge, the same result may be accomplished by employing different versines for the cable curves. Thus, in the bridge designed by Mr. Gustav Lindenthal for the North River Bridge Co., the stiffening is obtained by trussing between the cables and by continuous longitudinal platform girders. As these two systems have different periods the chance of cumulative oscillations is greatly reduced. In the Niagara Suspension Bridge the two systems of cables have versines of 54 and 64 ft., respectively, and consequently different periods of oscillation. The arrangements to prevent deflections due to the moving load and the wind will receive consideration in other parts of this report.

(To be continued.)

THE PRESENT STATUS OF FACE-HARDENED ARMOR.*

The apparent difficulties which at first delayed the the development of face-hardened armor in this country, and which were, by some, regarded as insuperable, have either disappeared upon closer inspection or been practically overcome. The difficulty of securing structures to the hard face, in default of knowledge as to the exact location of the fastenings, is also in course of solution. It was found feasible to tap and drill holes in the face of the plate at any stage of the process prior to hardening without detracting from the plate's resistance; but, as it was impossible to locate these holes with precision without fitting the armor into place, this method was abandoned in favor of one by which the carbon was prevented from penetrating over certain areas in the wake of the fastenings. This method also had its disadvantages in that the carbon gases frequently seeped through the protecting material and carbonized the surface beneath. The most satisfactory method, and one which will probably be employed in the future, is that of electrically annealing the surface to be drilled. The greatest objection to the face hardening or Harvey process, and one which seems least likely to be overcome in the immediate future, is its expense.

Dimensions and Shapes of Harveyed Armor Plates now Manufactured for the U. S. Navy.

Length and width.	Thick. of plate.	Shape of sec.	Curvature.	No. plates now mf'd.
ft.ins.	ft.ins.	ins.		
16 7×7	6	18	Tapered....Shaped to side.....	27
12 00×8	4	17	Rect'ng'lr...28°, radius 15' 10''..	52
10 00×6	9.5	15	" ...60°, radius 14' 3''...	16
17 6×6	9.5			
20 00×6	11	12	Tapered....Shaped to side.....	21
19 00×6	6	12	" " "	15
25 9×4 to 10 3×4	8 to 8		Rect'ng'lr..120°, radius 9' 3''...	16
"		8	" 103°, radius 11' 00''..	6
"		8	" 76°, radius 11' 00''..	6
"		8	" 72°, radius 9' 3''...	19
"		7½	" 72°, radius 11' 00''..	10
"		6	" 120°, radius 9' 3''...	46
19 4×4	8	4	" 130°, radius 9' 6''...	2
8 8×4	8	4	" 52°, radius 9' 6''..	2
12 00×7	10	4	" Curved to side.....	31
17 9×4	4	3½	" 120°.....	6
13 00×8	6	3	" Curved to side.....	32

It would not be proper to dismiss the subject of manufacture without considering the effect of nickel upon it. Mr. Ellis, in an able essay delivered before the Association of British Naval Architects in March last, discusses the advantages and disadvantages of nickel in armor plates as treated by the Harvey process in England. In certain respects the experience in the United States is different. The decision of the Armor Board of 1890 that the Schneider nickel steel plate was softer than that of steel, and allowed greater penetration, was correct for those two plates. Our armor makers, however, have had no difficulty in making oil-tempered nickel steel armor far stronger and more resisting than that of simple steel, while it still retained the characteristic toughness of the nickel. To any metallurgist acquainted with the infinitude of results that may be obtained by a variation in the composition and treatment of simple steel, the advantageous possibilities arising from the introduction of so benign an ingredient as nickel must be apparent. In other words, where simple steel is strong and tough, both qualities may be improved by adding the proper amount of nickel.

The susceptibility of nickel steel to treatment is remarkable, and yet this steel may be abused in the most shameful way without failure. For this reason the smaller percentage of losses in manufacture will go far towards wiping out the increased cost of machining the tougher material. Nickel appears to render the carbon more sensitive to hardening, and hence water-hardened Harvey plates of nickel steel are toughened at depths hardly affected in simple steel plates. Not only that, but the hardening is accomplished with less risk to the plate, and it is for this reason that manufacturers have been able to forgo entirely oil-tempering armor plates and obtain the increased resistance due to the more severe operation of water hardening.

Doubtless the difficulty of spontaneous hardening, which Mr. Ellis mentions as occurring in carbonized nickel steel plates, is due to the sensitiveness of the alloy after its long heat soaking, the plates being removed from the cementing furnace or uncovered in a cold, moist atmosphere while still at a high temperature. It is very rare that any difficulty of this sort occurs in the United States. In fact, the only doubt concerning the use of nickel in this country is the feasibility of raising its percentage, now 3.25%, still higher, the improvement and cheapening of the processes of reduction having considerably reduced its cost. In this connection, it is well to note that in the Poln, Austria, competitive armor trial of November, 1893, a Witkowitz unhardened plate, said to contain 5% of nickel, defeated five competitors, including a Vickers Harveyed simple steel plate and a Krupp gas-hardened plate. These plates contained between 2 and 3% of nickel. Finally, in England, where the nickel in Harveyed armor rarely exceeds 2.5%, its peculiar toughening effect is taken advantage of by employing it for unbacked structures, while the Harveyed all-steel armor, being more susceptible to racking, is now only fitted on backing. There is, therefore, nothing in the present application of the Harvey process, nor its future possibilities, to indicate the disuse of nickel in armor; rather that by increasing its percentage the toughness of the foundation plate and its resistance as a whole may be increased.

The service tests for Harveyed plates for United States naval vessels require them to withstand two shots, the first delivered with the velocity which, according to the Gavre formula, would cause the perforation of a wrought-iron plate 10% greater in thickness, together with 36 ins. of oak backing, the requirements being that no crack shall extend from the impact to the edge, or from one edge to another of the plate, and at the same time through the entire thickness of the plate at an edge. The second shot is at the velocity which, according to the De Marre formula, would cause the perforation of a Creusot steel plate 15% greater in thickness, together with 36 ins. of oak backing, the requirement in this instance being that the projectile, or any fragment thereof, shall not pass entirely through the plate and backing.

These tests are but 15% more severe than those required for oil-tempered nickel steel plates, and are now 3% less severe than those fixed by the latest contracts in France. It has been claimed that the larger calibres employed in France make the test more severe. This is hardly the case, as in France cracking is not barred. The plate must resist perforation, no part of the backing must be exposed, and the plate must remain in such condition, as regards cracks, as to enable a second shot to be fired upon it. The velocity of the second shot will be 1.26 as compared with that for ordinary steel as obtained from the De Marre formula, and the blow of this shot shall fall at a point distant three to four calibres from the first. Should the plate stop this shot, a premium of 8% of the contract price will be paid. Should the plate fail to fill the conditions imposed for the first shot, then another shot will be fired with a velocity of 12% greater than that capable of piercing an equal thickness of steel, and if the plate successfully resists this attack, the lot may be accepted, but at a price 8% below that agreed to in the contract. It would thus seem that the minimum requirement in France, after all, is hardly as severe as our own; still there are three grades of quality and three prices under the same contract.

It must be remembered, however, that the tests in the United States do not, as abroad, fix a standard of excellence. They mark the inferior limit, as does the last shot mentioned in the French contract above. The poorest, not the average, plate in an armor group

*Abstract of a paper by Capt. W. T. Sampson, U. S. N., Chief of Bureau of Ordnance, read at the recent meeting of the Society of Naval Architects and Marine Engineers.

of from 300 to 500 tons must pass this test or the entire lot is rejected. With the careful inspection of the various delicate operations of manufacture, aided by physical and chemical tests, it has been possible for the inspectors to reject a Harveyed plate believed in every instance to be less resisting than any other in the group. Our service plates must, therefore, be regarded as generally exceeding the resistance of the plates tested by a considerable amount.

In the United States the necessity of developing the manufacture of armor has prohibited active competition. It was necessary to place orders and formulate specifications before practical business men could be induced to erect the required expensive plants, hence it was necessary at first to borrow largely from experience abroad. In England and on the Continent, where the armor manufacturers were, at the advent of the Harvey process, provided with plants in which the equipment had followed step by step the advance of the art, contracts are awarded to the firms producing the best material, so that an active competition exists. It is to be hoped that an actual comparison of the products of our own and foreign armor makers may be arranged at no distant day, if for no other reason than to correct certain false impressions that exist abroad as to the standard of acceptance in this country. Thus far 28 Harveyed plates, all but 7 being of nickel steel, have been tested in the United States, and 40, all of which but 14 were of nickel steel, have been tested abroad. In addition, 9 plates tested were face-hardened in various other ways. The owners of these special processes of face hardening have, however, in every instance also acquired the right to Harvey armor.

In England about 20,000 tons of armor of this description have been ordered, the latest contract being for 12,500 tons, intended for the barbettes and citadels of five first-class battleships, and Harveyed armor is now being manufactured for three battleships in England, two in France, one Danish vessel, and two Japanese. The great English firms of Cammell, Brown, and Vickers are all provided with Harveying plants, and in France, the St. Chamond, Chatillon-Commentry, Marrel Freres, and St. Etienne makers have adopted the process, the first three accepting contracts to furnish plates up to a thickness of 15.75 ins., St. Etienne making plates under 8 ins. in thickness. Schneider & Co. have also acquired the process, as well as the firms of Krupp, Dillingen, and Witkowitz, all of whom had previously employed special face-hardening processes of their own.

Carnegie 6-in. plates have kept out 6-in. projectiles with velocities up to 2,110 ft. per second, exhibiting a resistance, as compared with iron, of 1.93; while a Bethlehem 8-in. plate kept out an 8-in. projectile with a velocity of 2,004 ft. per second, showing a resistance 2.14 times that of iron. Nevertheless, the unjust and erroneous comparison is frequently made of the severity of the acceptance tests of armor in this country and the comparative tests abroad.

The advent of Harveyed armor, and the necessity of our navy being provided with projectiles capable of piercing it, if such projectiles could be made, were almost simultaneous. The standard of excellence to be struggled for was far in advance of what was, until very recently, regarded as attainable. The improvement in quality, however, has been remarkable. Two months ago our Harveyed armor, as mounted on the ships, was regarded as impenetrable to calibres equalling its thickness up to 8 ins., the impact occurring with service muzzle velocity. This was owing to the smashing of the projectiles on the hardened face. Projectiles of the latest design, however, would probably be able to perforate such plates practically undeformed at a fighting range of 1,500 yds. It has been reported that the Russians so easily overcame Harveyed armor with their special shells that they decided against it in favor of tempered homogeneous plates. They are yet to be heard from in this matter, however, and it is hardly possible that they have followed such a policy.

The theory has been advanced, however, that with the improvement of projectiles, the Harveyed plate will lose its peculiar advantage now due to its smashing the projectile, and will become really less resisting than a homogeneous plate of equal thickness, on account of the softer body and back of the Harveyed plate. This argument is fallacious; the principle of a non-homogeneous hardened face, combined with a decrementally toughened body and back, is correct. The homogeneous plate, as compared with the non-homogeneous, must always be perforated in detail. Should the homogeneous plate of the future be greatly superior to the face-hardened plate of to-day, it will be made still more resisting by employing it as the foundation plate to which the process of face-hardening is applied.

Whatever conclusion is reached, the fact remains that Harveying in its present state has increased the resistance of armor fully 35% and perhaps 50%, according to the thickness of the plate. It has also brought about a great improvement in the quality of our projectiles, and in doing so has perhaps lost some of the advantage it held over them at first, when subjected to direct impact. Its superiority under inclined impact is nearly as great as it ever was, and it does not seem possible that in this respect the relation between gun and armor will for a long time to come take the old position held in the time of soft armor. Perhaps the relation may be restored, however, should the thickness of armor be reduced to a point allowing no more than the old resistance, in order to distribute it over a larger area or divert the weight thus saved to other uses.

PERSONALS.

Maj. Jesse R. Crawford, formerly Superintendent of the old Portage Railway, died at Gaysport, Pa., Nov. 14, at the age of 84.

Mr. J. M. Buckley, formerly Assistant General Manager, of the Northern Pacific R. R., died at Hot Springs, Ark., Nov. 15.

Mr. M. B. Rice has been appointed General Superintendent of the Gulf Terminal Railway & Navigation Co., at Tallahassee, Fla.

Mr. Thomas B. Entwhistle, Building Inspector at Washington, D. C., and formerly in the contracting business, died at Georgetown, D. C., Nov. 12.

Mr. W. O. Sprigg, Master of Transportation of the Staten Island Rapid Transit Ry., has been appointed Superintendent, with headquarters at St. George, New York.

Mr. C. W. Huntington, Superintendent of the Des Moines Northern & Northwestern Ry., has resigned to accept the position of General Superintendent of the Iowa Central Ry.

Mr. John Platt has opened an office as consulting and contracting engineer in the Electrical Exchange Building, 136 Liberty St., New York. He will give special attention to hydraulic machinery, adapting to American requirements the specialties of Fielding & Platt, of England.

Mr. James L. Greenleaf, C. E., for twelve years professor in the Engineering Department of Columbia College, has opened an office for general consulting practice at 135 Broadway, New York city. Mr. Greenleaf will, after July, 1895, engage permanently in the active practice of his profession.

SOCIETY PROCEEDINGS.

BROOKLYN INSTITUTE OF ARTS AND SCIENCES.—At the meeting in the Art Building on Nov. 20, Mr. B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, delivered an interesting lecture on "The Battle of the Forest," profusely illustrated by stereopticon views.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The offices of the Institute have been removed to rooms 1009 and 1010 Havemeyer Building. The meetings will be held as heretofore at No. 12 West 31st St. The offices are open from 9 a. m. to 5 p. m., and over 100 electrical, mechanical and engineering periodicals are kept on file.

ENGINEERS' CLUB OF CINCINNATI.—At the meeting on Nov. 15 the proposed ship canal between Toledo and Cincinnati was discussed. Mr. Latham Anderson said the canal, as proposed, would be about as small as a ship canal could be. He spoke of the advantage of such a means of transportation for the traffic in iron ore, and referred to the legislation that had been made with reference to the building of a canal, in which he had been concerned as a promoter. In answer to a question whether there was any probability that the lower terminus of the canal would be near Cincinnati, or at the natural outlet, the mouth of the Miami River, Mr. Anderson responded that it seemed to him that it would be very irrational for the terminus to be distant from the city, as canals are made for men and not for places. It was suggested that Mill Creek be made the bed of the canal for its lower terminus, and Mr. Anderson said that if Cincinnati would not take the trouble to make the cut through the hills to Mill Creek Valley it ought to be left out in the cold. Mr. Burke said that a report would be made to the Board of Trade and Transportation recommending that all the bodies interested use their influence toward securing an extension of time for the engineers in charge to make their report in, and to secure an amendment of the act authorizing the survey by which the report can be secured on a larger canal. He suggested also that it be endeavored to secure a further appropriation for survey purposes from some future Congress; and if that cannot be secured, make a canvass for voluntary appropriations among the cities interested.

MONTANA SOCIETY OF CIVIL ENGINEERS.—At the meeting at Helena, Mont., Nov. 10, the committee on county surveyors submitted a report in the form of an amendment to the present statute, providing that the expenses of county surveyors should be paid while they are on duty on surveys. Mr. McNeill read a report on a proposed change in the road laws, by which the county surveyors would have charge of highways and highway bridges. It was voted to refer the reports and the whole matter to a select committee of three members of the society, with instructions to report a bill to be presented to the next legislature, covering all the points referred to. Mr. A. M. Ryon, of the College of Agriculture and Mechanic Arts at Bozeman, who was appointed a committee at the last annual meeting to experiment and report upon a more exact method of determining what is meant by a "miner's inch" by the statute of Montana, made a very full and instructive report. It was voted that Professor Ryon be requested to draft a bill on the subject to be read at the next meeting of the society, so that it may be discussed by the members, and got ready to present to the next legislature.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting will be opened at 9 p. m. Monday evening, Dec. 3, with a discussion of topical questions. On the following morning a meeting will be held for disposing of Society business, and papers by W. J. Keep on "Relative Tests of Cast Iron," and by Geo. M. Sinclair, "Notes on Steel Forgings," will be read. Other sessions for the reading and discussion of papers will be held on Tuesday evening, Wednesday morning, Thursday morning and Friday morning. The list of papers announced is as follows:

Samuel and S. S. Webber: "Trials of a Vertical Triple-Expansion Condensing Pumping Engine at the Trenton Water-Works."

Miller-Peabody: "Tests on the Triple-Expansion Engine at the Mass. Inst. Tech."

F. W. Dean: "Trial of Leavitt Pumping Engine"; "Trials of a Recent Compound Engine with a Cylinder Ratio of 7.1"; "Changing the Suction System of a Pumping Engine."

Gaetano Lanza: "Tests of the Strength of Spruce Columns."

C. V. Kerr: "On the Theory of the Moment of Inertia."

Charles T. Porter: "Comparison of the Action of a Fixed Cut-off and Throttling Regulation, with that of the Automatic Variable Cut-off on Compound and Triple-Expansion Engines"; "Description of a Cam for Actuating the Valves of High-Speed Steam Engines"; "Description of an Improved Steam Separator and an Improved Steam Jacket"; "Description of an Improved Centrifugal Governor and Valve."

Gaetano Lanza: "Stresses in the Rims and Rim Joints of Pulleys and Flywheels"; "The Application of Brakes to the Truck Wheels of a Locomotive."

W. F. M. Goss: "An Experimental Study of the Effect of the Counterbalance in Locomotive Drive Wheels upon the Pressure of Contact Between Wheel and Rail."

C. J. Field: "Present and Prospective Development of Electric Tramways."

Thos. D. West: "Relative and Special Tests of Cast Iron."

M. P. Wood: "Rustless Coatings for Iron and Steel."

Geo. W. Bissell: "The Effect of Clearance on Economy of a Small Steam Engine."

D. S. Jacobus: "Results of Experiments to Test the Accuracy of Small Throttling Calorimeters."

John H. Barr: "Experiments on a System of Governing by Compression."

Jos. C. Platt: "Straightening a Leaning Chimney, 100 ft. high."

A. W. Robinson: "Drawing Office Appliances."

L. S. Randolph: "Strength of Railway Car Axles."

Geo. R. Henderson: "A Graphical Method of Designing Springs."

On Wednesday evening there will be a reception for members and their friends at Sherry's. Special railway rates on the certificate plan have been asked for and will be secured if used by 100 or more. It is announced that the meeting in the summer of 1895 will probably be held in Detroit, Mich.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The annual meeting was held in New York, at the house of the Mechanical Engineers, Nov. 15 and 16. The reports of the Secretary and Treasurer showed a total membership of 413, and 50 applications for membership were acted upon. The finances are in a satisfactory condition, showing a larger balance than last year. Mr. Clement A. Griscom, of Philadelphia, President of the International Navigation Co., was re-elected President. In a brief address Mr. Griscom stated that shipbuilding had suffered severely from the general depression and then explained the value of a merchant marine as a support to a navy.

It should be understood that a modern naval force, with all its multitude of equipment, arms, munitions and accessories, cannot be produced on the spur of the moment, but is the product of naval architects, steelmakers, and a host of others whose skill can only be obtained by experience. The personal element in warfare, as in peace, is always of the greatest importance, and, therefore, an adequate navy is necessary, not only for the actual representation of power and force, but also to secure to our officers and men those superior nautical aptitudes only to be obtained by continued experience at sea. The full development of a naval force, however, is not possible unless the growth of the merchant marine kept pace with the naval development. My quotation of the words of Sir Nathaniel Barnaby in my address to you last year: "No nation could maintain an efficient navy without a prosperous commercial marine to support it," has still the force of an axiom. And it should not be overlooked that in time of war the conversion of fast mail steamers into armed cruisers is generally recognized among all maritime nations as a most formidable means of offence or defence for any country so fortunate as to possess them. To provide the expansion of naval personnel rendered necessary in time of war, there must be a well-trained merchant marine to draw upon, and those nations which have not encouraged shipbuilding and

shipowning in times of peace must inevitably suffer from their short-sighted and narrow policy when confronted with a powerful hostile fleet.

The first paper presented was one entitled "Some Suggestions of Professional Experience in Connection with the Naval Construction of the Last Ten Years, 1884-94," by Admiral Richard W. Meade. He remarked that as far back as 1863 he urged the use of iron frames and in 1875 stated before a committee that it would pay the government to burn the "Trenton" on the stocks as she stood and build an iron ship in her place. Considering the comparison between our navy of 1884 and that of 1894 it is not remarkable that other nations respect our naval progress. We have now on the navy list 42 vessels, built or being built, which we call the "new navy," and which compare favorably with ships of the same type on the other side of the Atlantic, while some of our types are superior to those of similar class built in England. He disapproved of the new high-speed commerce destroyers, considering that such vessels can better be obtained from the merchant marine in time of war. In his judgment the "commerce destroyers" of the future will be such boats as the "Lucania," "New York," "St. Louis" and "Majestic." None of the boats yet built embodies his ideas of the ordinary large cruiser, but the "Chicago" will approach these ideas if her new engines and boilers do not occupy more space than the present ones. He emphasized the fact that without good seamen and officers the ships and guns are of comparatively little use.

The discussion turned largely on the use of merchant vessels in time of war, and Commodore Melville drew comparisons between the "Campania," carrying some 4,000 tons of coal, and the commerce destroyer "Minneapolis," of high speed, but much less bunker capacity. Admiral Meade advocated the use of small, handy vessels, which can run close inshore, and instanced the recent troubles on the Mosquito Coast, where the "Columbia" had to anchor several miles off shore and send men to the land in launches and boats. The "Columbia" is a very fine vessel, but not suited for the hack work of the navy. Mr. Wilson, naval constructor, showed that there had not been the opposition to iron vessels which Admiral Meade intimated, as in 1873 the constructors sent to the Navy Department plans for iron cruisers, and the advisory board of 1881 recommended iron or steel.

An abstract was then read of a paper by Mr. Berton on "The Use of Small Models for the Determination of Curves of Stability," and this was followed by a paper on "Some Obstacles to Ship Building and Owning in This Country," by Mr. Geo. W. Dickie, in which he stated that there must be: 1, a patriotic ambition throughout the country to carry the products of our industry under our own flag to every country which cares to exchange products with us; 2, wise national laws to protect and foster our merchant marine; 3, state and municipal laws on the part of sea-girt states and maritime cities encouraging shipbuilding and shipowning within their own borders. In the discussion, Mr. Cramp referred to the impossibility of introducing the piecework system in shipbuilding in this country, owing to insufficient amount of work. English builders make a specialty of certain classes of vessels, and can thus reduce the cost of patterns, etc., to a minimum, especially in the building of tramp steamers. As the cost of labor and maintenance are much greater under the American flag, shipowners are not likely to sail their ships under that flag merely for patriotic reasons, unless something is done by the government to encourage such a change.

A paper on "Electricity on Shipboard" was read by Mr. S. D. Greene, and of this we publish an abstract. In the discussion it was stated that the Sound steamers first carried the searchlight on the bow, but this dazzled the pilots and it was removed to the top of the pilot house, which was an improvement, but it was then realized that the object of the searchlight in fog should not be to enable the pilot to see ahead but to warn other vessels. The light is now therefore thrown upward at an angle, making a blur of light in the fog which is readily distinguishable. Steam apparatus for sounding the whistle regularly is also used, and may be arranged so that each vessel blows a different series of blasts. Mr. Holloway said that such a whistle attachment had been used on the lakes for 10 or 12 years.

Mr. E. Cheneau then read a paper on "Cellulose and Its Application to Warships." A few years ago Admiral de la Barriere, of the French navy, discovered that a special kind of cellulose extracted from the husk of the cocoanut had some remarkable properties which would make it very valuable for the purpose of securing the "unsinkability" of ships. The amorphous cellulose, as the inventor named it, is extremely light, its specific gravity being only one-fourth that of cork. When compressed to a certain degree it is highly elastic and swells rapidly when in contact with water, while it does not rot or decay and is not liable to be attacked by insects, but must be protected from contact with iron and water or oxidation will occur. The application of cellulose compressed in cofferdams, in the shape of a self-obturating belt, closing automatically the holes made by projectiles, has been adopted for all the latest ships of the U. S. navy. The inventor proposed to use other walls composed of blocks or briquettes of cellulose, to oppose the inrush of water. Tests made with tanks filled with cellulose and pierced by shells and torpedoes have proved the value of the material, and the author cited instances where the practical efficacy had been proved in cases of collision, shot holes and grounding of vessels. Cellulose leak stoppers and collision mats were also referred to.

An interesting paper on "The United States Triple-Screw Cruisers 'Columbia' and 'Minneapolis'" was then read in abstract by Commodore Geo. W. Melville, Chief of the Bureau of Steam Engineering. The paper gave detailed dimensions and description from a paper by Passed Asst. Eng. T. F. Carter, U. S. N., in the "Journal of the American Society of Naval Engineers." He pointed out that the use of three screws was not new or original, although never used before with machinery of such power. The "Columbia" showed 22.8 knots with 18,500 I. HP., and the "Minneapolis" 23.07 knots with 21,000 I. HP. The economy of propulsion was very marked. Admiral Meade said that his experience with the "Columbia" on the North Atlantic squadron was that she was not economical, and he had never been able to get such speed with the regular crew as the builders did with picked men and picked coal. He intends some day, when this ship is in good condition, to wait in New York harbor for the "Teutonic" to go out, and then see if the "Columbia" can catch the "Teutonic." Mr. Holloway said that twin-screws were adopted on the lake on account of greater handiness in the harbors. A twin-screw passenger ship was changed to a single-screw freighter and showed little decrease in speed, but great decrease in fuel economy. A single screw in the center of the stern post acts against a current running against it and meets a greater resistance than a screw at the side of the ship working in a current flowing away from the ship.

The first paper read on Nov. 16 was one by Prof. C. H. Peabody and Asst. Prof. E. F. Miller on "A Dynamic Steam Engine Indicator Tester." This is a machine for testing steam engine indicators by direct comparison with mercury columns, and has the peculiar feature that the indicator under test describes diagrams similar to those taken from a steam engine. This has been in use for about a year at the Massachusetts Institute of Technology.

In a paper by Mr. Philip Hichborn, Chief Constructor, U. S. N., on "Experience Gained with Our New Steel Ships in Regard to Care and Preservation," reference was made to the constant care necessary to keep such ships and their machinery in serviceable condition, as the wear and tear is great. Admiral Meade believed in sheathing the vessels with wood and copper, and thought perhaps the composite system of construction might be best for smaller vessels. Mr. Fernald stated that electro-plating the armor with copper had been tried on a French warship, but it was a dismal failure, the great difficulty being that in case of any chafing or puncturing of the plating the corrosion was concentrated at these spots. One member stated that the surfaces of ironwork to be in contact, such as backs of angle irons riveted together, should not be painted, as the oxidation will hermetically seal the interstice and be a far better protection.

A paper by Capt. W. T. Sampson, U. S. N., Chief of the Bureau of Ordnance, on "The Present Status of Face-Hardened Armor" was then read, showing the advantages of the Harvey process and of nickel-steel. Captain Bartlett said that a heavy projectile at low velocity was more dangerous to armor than a light projectile at high velocity, owing to the racking effect of the former, and as it is almost impossible at sea for an ogival-headed shell to strike a right-angle blow on the armor, flat-headed projectiles should be used. In experiments made by him the sharp edge of the shell bit into the inclined plate, turning the shell at right angles to the plate so that it went through. Such projectiles will go as straight, but not carry so far, but the range of our modern guns is too great for service uses, the range being from 7 to 12 miles, while fighting range is more likely to be 1,500 or even 500 yds. Sir Joseph Whitworth had pointed out that a flat-headed projectile was the only one that could be fired into water without changing its direction, and would therefore be valuable in firing at torpedoes or submarine boats. Mr. W. H. Jaques referred to the great value of nickel in armor-plate as proved in this country and abroad, although the British Admiralty has decided against it.

The next paper was on "Hydraulic Power for Warships," by Mr. Albert W. Stahl, recommending such power for all machinery outside of the main engines, and using high-speed tangential water wheel for driving the dynamos. Mr. Cramp did not favor such power for hoisting, etc., but preferred steam friction gear winches, which are much less noisy than the cog-wheel gearing used on English ships. Mr. Williamson said that the hydraulic hoisting gear on the booms over the hatches on the "New York" and "Paris" was very troublesome, and had been already replaced by steam winches on the former, while a similar change is to be made on the latter. A special hydraulic engineer had to be carried, and there was more trouble and expense with maintenance and repairs. The hydraulic gear will not be used on the "St. Louis" and "St. Paul." Fine steering is very important, but is less easily obtained with hydraulic than with steam or electric steering gear. In fact, he has taken the hydraulic steering gear out of several vessels and replaced it with steam gear. Mr. Stahl said that the movement of the steering gear could be adjusted very delicately, being effected by the admission of water through a very small pipe to the plunger, and in any case it was for warships and not for merchant ships that he advocated hydraulic power.

Mr. Wm. J. Baxter then read "Notes on Launching," describing the methods of launching the cruiser "Raleigh" and battleship "Texas" at the Norfolk navy yard in 1892. Mr. Stahl said that the warships built at the Union Iron Works, San Francisco, were launched into a bed of very soft mud a little distance from the ways, the shoal being dredged out to give the vessel a draft of 5 ft. of mud. Mr. Holloway referred to the practice at lake yards of launching vessels sideways, and instanced vessels of 42-ft. beam launched in a 60-ft. canal. In the next paper, on "Yachts in America and England," Mr. Lewis Nixon described the development of the yachts under the almost opposite rules and conditions of the two countries. The English rule, based upon tonnage measurement, laid a heavy tax upon the beam and a light tax upon the length, while the depth and sail power were not taxed, so that naturally the development was in the line of a narrow deep boat. The yachts of the two countries are now, however, becoming more and more alike, points of superiority being appropriated by rival designers, the use of the centerboard, however, being a radical difference on the part of American boats. While for shallow harbors and cruising a centerboard is a convenience, it is unfortunate that it should be considered essentially American, or that our success should be so often attributed to it. A heavy centerboard like that of the "Vigilant" is a positive drawback, as it greatly increases the draft, and where a vessel with a deeper draft than the "Vigilant" could have gone, that boat struck the bottom when the centerboard was down. Its great weight (3½ tons) when lowered was doubtless an aid to stiffness, but the same amount of stiffness could have been obtained in another way. A more important objection is that it is a device which, so far as the true aim of yachting is concerned, is neither seamanlike nor sportsmanlike. That the designer of the "Vigilant" can develop a boat as well suited to English waters as to our own is shown by the wonderful performances of the "Dakotah" which, under all conditions of weather and running, was the best boat of her rating in English waters during the past season, winning 25 first prizes out of 33 starts.

A paper on "Accessibility and Circulation of Water-Tube Boilers" was read by Mr. L. D. Davis, and this was followed by one on "Recent Light Draft Gunboats of the U. S. Navy," by Mr. J. J. Woodward, Naval Constructor, U. S. N. Captain Bartlett thought that the seagoing gunboat should have greater sail power and that for river service a sidewheel steamer would be preferable to the twin-screw steamer described. The last paper presented was by W. F. Durand and G. R. McDermott on "An Approximate Formula for the Wetted Surface of Ships," and this was read by title only on account of its mathematical character.

COMING TECHNICAL MEETINGS.

FRANKLIN INSTITUTE, PHILADELPHIA.
Nov. 23. "The Photochromoscope," Mr. F. E. Ives. Secy., W. H. Wahl.

ENGINEERS' CLUB OF INDIANAPOLIS.
Nov. 24. Secy., C. C. Brown.

DENVER SOCIETY OF CIVIL ENGINEERS.
Nov. 27. Secy., F. Ed. King, 36 Jacobson Block.

ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 1. Secy., L. F. Rondinella, 1122 Girard St.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3 to 7. Secy, F. R. Hutton, 12 W. 31st St., New York.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Dec. 3. Secy., C. L. Annan, City Engineer's Office.

WESTERN SOCIETY OF ENGINEERS.
Dec. 5. Secy., Thomas Appleton, Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF ST. LOUIS.
Dec. 5. Annual meeting. Secy., W. H. Bryan, Turner Block.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 5. Secy., Francis Collingwood, 127 E. 23d St., N. Y.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 6. Secy., C. H. McLeod, 112 Mansfield St., Montreal.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Dec. 7. Secy., O. Von Geldern, 719 Market St., San Francisco.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Dec. 8. Secy., G. O. Foss, Helena, Mont.

WISCONSIN POLYTECHNIC SOCIETY.
Dec. 10. Secy., Geo. G. Mason, 144 8th St., Milwaukee.

ENGINEERS' CLUB OF KANSAS CITY.
Dec. 10. Secy., F. W. Tuttle, Baird Building.

CIVIL ENGINEERS CLUB OF CLEVELAND.
Dec. 11. Secy., F. C. Osborn, 721 Hickox Building.

NORTHWESTERN SOCIETY OF ENGINEERS.
Dec. 11. Secy., D. W. McNorris, Burke Building, Seattle, Wash.

NORTHWESTERN RAILWAY CLUB.
Dec. 11. Secy., W. D. Crosman, Ryan Hotel, St. Paul.

NEW ENGLAND RAILROAD CLUB.
Dec. 12. Secy., F. M. Curtis, P. O. Box, 1576, Boston, Mass.

ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 13. Secy., Hunter McDonald, Nashville, Tenn.

ENGINEERS & ARCHITECTS' CLUB OF LOUISVILLE.
Dec. 13. Secy., G. W. Shaw, Norton Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 14. Secy., D. W. Meeker, St. Paul, Minn.

ENGINEERS' CLUB OF MINNEAPOLIS.
Dec. 17. Secy., E. Nexsen, Kasota Block.

WESTERN RAILWAY CLUB.
Dec. 18. Secy., W. D. Crosman, Rookery Building.

COLUMBIAN ENGINEERING SOCIETY.
Dec. 18. Secy., W. F. Hart, Washington, D. C.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
Dec. 19. Secy., J. H. Pilcher, Roanoke, Va.

BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 19. Secy., S. E. Tinkham, 36 Bromfield St.

NEW YORK RAILROAD CLUB.
Dec. 20. Secy., John A. Hill, Temple Court, N. Y. City.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 20. Secy., D. Carhart, Carnegie Library Building, Allegheny.

ENGINEERS' CLUB OF CINCINNATI.
Dec. 20. Secy., J. F. Wilson, 24 W. 4th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Dec. 20. Atlanta, Ga., Secy., F. A. Charpiot, Macon, Ga.

CENTRAL RAILWAY CLUB.
Jan. 13. Secy., S. W. Spear, East Buffalo Iron Works, Buffalo, N. Y.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

A brief note published in this column in our issue of Sept. 27 asked for information concerning the record of one Francis F. Hopp, a civil engineer who was employed in the City Engineer's Department of Chicago in 1892, and who later held the position of inspector on government levee work near New Orleans. The information now in our possession justifies us, in the interest of the profession, in warning engineers not to trust this man in any way without investigating his past record for themselves.

An excellent illustration of the rapid awakening to the importance of the reform in the sanitary works of our cities which is going on all over the country is furnished by the city of San Antonio, Texas. This has grown rapidly from a straggling frontier town until it has now a population of nearly 40,000; and it has thus far had practically nothing in the way of a sewerage system. This defect is now to be remedied, not by a piecemeal and haphazard plan, as is usually the practice when a city is belated in adopting new improvements, but by the construction of a complete system of sewers 75 miles in extent, proposals for which are now called for. If the present activity in sanitary work continues a city over 10,000 inhabitants without a sewerage system will soon be an anomaly, as it should be.

The agitation for the removal of grade crossings is spreading rapidly in Western cities. We noted in our issue of Nov. 1 the pugnacious action of Joliet, Ill., a little town of 23,000 inhabitants, which proposes to fine each railway company $100 per day for every day of failure to remove grade crossings. Indianapolis is agitating the subject, and is likely to compel the railways to undertake the work of track elevation at an early day. Now Dayton, O., with a population of 60,000, has had careful surveys, plans and specifications prepared by its city engineer, in co-operation with a consulting expert, for the removal of grade crossings throughout the city, and has been met by the railways with the offer to build a new union depot and remove the worst of the grade crossings if the city will pay the land damages. If grade crossings are to be eliminated in all cities of 50,000 population and upward, the railways will have to make some large additions to their capitalization, for there are few railways nowadays which can pay for such extensive improvements out of their surplus fund.

The report of the Board of U. S. Engineer Officers upon the maximum practicable length of span for suspension bridges, of which we begin the publication in this issue, forms one of the most valuable and instructive engineering investigations of the day. The board has performed its work thoroughly and conscientiously, though laboring in a field which has hitherto been practically unexplored. The report is instructive for the authorities and data used and the methods given for arriving at results; and it is interesting to engineers, and to capitalists as well in this day of daring projects, in placing for the first time upon an intelligent footing the possibilities of long-span structures. With 1,600 ft. as the maximum existing span for a suspension bridge and 1,700 ft. as the longest bridge span in existence, the suggestion of one of 4,335 ft. span is startling, to say the least, with its towers over 700 ft. in height and its enormous suspended dead load of 233,899 tons. The board, however, wisely points out that indeterminate local elements constitute about 60% of the cost of such large bridges in cities, the only place where possible traffic would warrant their construction at all, and it is not probable, for the present at least, that engineers will find capital willing to back their ambition to the extent of nearly a mile of span. It is encouraging, however, to learn from such competent authority that it is not only possible, but practicable, to build a six-track railway suspension bridge of 3,200 ft. span for the sum of $23,000,000. The board further states that the amount of traffic such a bridge would accommodate in crossing the Hudson River at New York would be sufficient to warrant this cost of construction, large as it seems; but it should be noted that this is not saying by any means that the bridge can attract a traffic sufficient to pay the interest on its cost. That is another story.

It is generally conceded that when two parties, each acting in good faith, are unable to agree with reference to a matter over which they are in controversy, it is an evidence of wisdom to resort to arbitration rather than to the courts for a settlement of the difficulty. In the case of corporations, however, this good rule has been more honored in the breach than the observance. The calendars of courts everywhere are crowded with corporation litigation and it is comparatively rare to see two corporations referring matters at issue between them to a disinterested party for adjudication. We note with interest, therefore, the record of an arbitration between the Chicago & Northwestern and Elgin, Joliet & Eastern Indiana Railway companies just concluded at Chicago. On Sept. 9 the latter road switched 17 loaded freight cars, destined for the Northwestern Railroad, onto a spur track connecting the tracks of the two companies at Barrington. During the day the cars ran across the main line of the Northwestern, where they were struck by the outgoing St. Paul express on that road, wrecking the engine, two or three of the passenger cars, three of the coal cars, and killing the fireman of the passenger engine and seriously injuring several passengers. The Northwestern officials charged the Elgin road with the responsibility for the accident, and after the denial by the officers of that company of such responsibility and failure to agree upon any basis of settlement, both sides finally agreed to refer the matter to a board, consisting of Messrs. B. Thomas, Vice-President and General Manager of the Belt Ry., of Chicago; C. H. Chappell, General Manager of the Chicago & Alton, and Henry B. Stone, formerly Second Vice-President of the Chicago, Burlington & Quincy system. After hearing the evidence the board decided that the damage done by the wreck should be divided equally between the parties.

The Nicaragua Canal project is showing decided signs of renewed life and indications point to an early resumption of work, on a scale at least sufficient to preserve the concessions until the work can be pushed with the vigor necessary for speedy completion. According to well-authenticated rumor Messrs. Bartlett and Weed, of the reorganization committee, have succeeded in securing a very considerable amount of capital, both here and from abroad, and more is promised speedily. Meanwhile bills are being pushed through the Vermont Legislature incorporating the Nicaragua Company, which it to succeed to all the rights of the Nicaragua Canal Construction Company, now in the hands of a receiver, and granting much greater powers than did the Colorado charter of the old company. Hon. Warner Miller stated to the legislative committee that all but 1,000 shares of the 120,000 shares of the old company had been turned over to the reorganization committee, and this committee now wanted power to get to work again, at once, as the time limit on the concessions was rapidly expiring. In answer to the question why a private corporation was attempting to perform a work of such magnitude, properly the work of a national government, Mr. Miller said that the company stood ready at any time to turn the work over to the United States upon any just and fair terms, and the company had already made a proposition whereby the United States Government might own the canal by guaranteeing the company's 3 per cent. bonds for 50 years, and then taking the property. The promoters of this important public work feel much encouraged by the signs of approaching better times financially, and by the feeling that the new Congress may take a much broader view of the project from a national standpoint, especially as President Cleveland has already expressed himself so favorably upon the national questions involved. But these promoters also declare that they have sufficient warrant in American and foreign capital promised to actively renew work even upon the basis of a private corporation acting without direct government aid.

The Manchester Canal, opened about one year ago with imposing ceremonies, is at a standstill as far as business is concerned, says the London "Financial Times." The reason given is the very considerable reduction made in rates by the competing railway lines, which has gone to such an extent that there is no longer any decided inducement to use the canal, with all its well-known inconveniences to commerce. If the aim of its promoters was simply to reduce the cost of carrying goods to and from Manchester, that end has been realized, for the time at least; for on some classes of cotton goods the rate has decreased three shillings per ton from what it was before the canal was built. But the holders of canal shares and the taxpayers of Manchester, who have paid their money for this $75,000,000 canal enterprise, naturally want to know what is going to be done about it. Some of these advocate the conversion of the undertaking into a public trust, while others suggest that the united railways should buy the canal. As the "Times" suggests, the shares could probably be bought at half their par value, and the railways could offset interest charges by again raising rates, and utilize the canal to some extent in relieving railway traffic by converting it into a barge canal.

So inglorious an ending as this to one of the greatest canal undertakings of the century will be decidedly discouraging to schemes proposing canal competition with railway lines under somewhat similar conditions. In the English case, Manchester-Liverpool rates were doubtless high before the canal was built, and the rates now charged may represent a fair return upon operation and thus be permanent. On the other hand, the railways are doubtless making every effort to discourage the development of canal traffic, and may thus handle Manchester goods with little profit. Be this as it may, there are certain disadvantages in handling heavy shipping in a canal, and especially in a lock canal, that will assist the railways in their competition with the canal. Promoters of similar ship canal schemes in this country will do well to carefully study the record of the Manchester Canal and profit by the experience which is being accumulated on that expensive work. At present the outlook for the investors in that enterprise is anything but a bright one.

WATER SUPPLY FROM SATURATED BEDS OF SAND AND GRAVEL.

As a source of water supply, saturated beds of clean sand and gravel, like those found on the south side of Long Island, possess advantages in purity and in steadiness of supply up to certain limits. But as regards the quantity of water available from such underground reservoirs, at any reasonable cost, many people are sadly astray in their calculations, and among them we must class

our correspondent, whose letter is published in this issue.

In the first place, instead of 42 ins. of rainfall in that region, as assumed by Mr. Creuzbaur, we find the engineers of the Brooklyn Water Department using 35 ins. as an average annual precipitation, and Mr. Kirkwood, in his well-known reports, considers 30 ins. a safe average when due regard is paid to years of light rainfall. Of this rainfall about 15 ins. is consumed by evaporation, by vegetation and by soaking into the ground. This leaves from 15 to 20 ins. annually which either runs directly into the streams or comes to the surface in springs. Just how much of this latter quantity (the "run-off," as it is generally called) can be utilized for water supply depends largely upon the money expended in means for intercepting underground flow and in providing storage for the water that would otherwise go to the sea in floods after heavy rainfalls. According to the report of Chief Engineer Van Buren, 1880 was an exceedingly dry year and no water was wasted over the dams at the various reservoirs of the system of water supply then existing. From the entire watershed of 60 sq. miles he obtained, in that year, an amount of water equivalent to only 9½ ins. of the rainfall. If our correspondent will use these figures in his calculations he will very materially reduce his estimates of available supply.

His general statement of the operation of driven wells is correct. Notwithstanding claims to the contrary, driven wells differ in no wise from ordinary dug wells, except in general dimensions and methods of operation. The air in them is not "exhausted," for air circulates freely in the ground, responds to any change in barometric pressure, and readily takes the place of any water drawn from the soil. In fact, the tube acts practically the same whether driven into natural porous soil or standing in a dug well. If the supply is forced by heavy pumping, it is also evident that a downward current must sooner or later be created in the "cone of influence" of the driven well, and with this may come surface impurities. In such cases the bed of sand intervening between the surface and the point of the driven well is not an absolute guarantee, as is a sand filter, against the entrance into the tube of surface contamination. If the draft is sufficiently great, channels are formed in time that will communicate directly with the surface, and down these channels surface water will find its way.

But when our correspondent claims among the advantages of the "underground gravitation flow system" unlimited storage capacity and greater purity of supply by reason of the water passing vertically through from 10 to 125 ft. of sand, and a passage through this sand of "thousands of feet horizontally," we beg to differ with him radically. No one doubts the existence on Long Island of an underground storage of pure water in enormous quantities, and the fact that the surface of this saturated bed of sand and gravel has a well-determined slope towards the sea is also fixed by observations made in numerous driven wells on the island.

But to utilize this stored water is not so easy a task as our correspondent seems to think. The seaward slope of this so-called water-table varies from 12 ft. to 8 ft. per mile, the steeper slope being found at points permitting a more rapid outlet for the water; or, in other words, providing a greater hydraulic head. This slope itself is the resultant of two factors; one representing the hydraulic or vertical head and the other is the horizontal distance required to consume in friction among the particles of sand and gravel the velocity of flow due to the head. The nature of the material has much to do with this friction, and consequently with the slope. If it is fine sand the resistance to flow is greater, the velocity is absorbed more quickly, and the slope is steep; while if the material is coarse and open the flow is less retarded and the slope is flat. This applies to the cone of driven wells, as well as to the water-table on Long Island, and until this nature of the material is ascertained by test wells, no safe estimate can be made of the contents of the cone of influence of a driven well, or the quantity of water to be depended upon.

It is a fallacy to assume that there is any flow, worth considering as stored water, in the saturated bed lying below this hydraulic grade line, or outside the cone of influence of a driven well. There is usually a very slow flow, or percolation out of it, amounting sometimes to about 2 ft. per hour; but for all storage purposes the natural hydraulic slope might as well cap a frozen mass of ice. Under normal conditions, the water continually escaping into the sea along the Long Island coast simply represents that portion of the annual rainfall that enters the ground and is not discharged by springs into surface streams or retained for maintaining moisture in the soil. This water flows down the slope, as over a sheet of ice, and this is all that the galleries of "the gravity flow system" would intercept; and while the hydraulic slope would be modified somewhat, in their immediate neighborhood, by these galleries or by driven wells, the quantity collected by them is only a part of the annual rainfall. The enormous "storage reservoir" of water—saturated sand—to draw upon for an indefinite quantity, does not exist, and such a system would waste all the rainfall now intercepted by the surface storage basin system.

The use of galleries to intercept this annual flow down the hydraulic grade line is no new thing; it has long been favored by the engineers of the Brooklyn Department as a means of utilizing a considerable amount of water now escaping to the sea and wasted, which comes from territory lying between the sections drained by existing storage basins. The scheme is now practically in use in the system, and a mile of such galleries emptying into a 50-ft. central well was recommended for an additional water supply by Chief Engineer Van Buren in 1880. As long ago as 1860, Mr. Kirkwood also wrote that he thought this escaping fraction of the annual rainfall might be intercepted by underground drainage; the objection he had to the plan was that some of these drains would have to be placed so low that it would involve pumping to deliver the water into the conduit.

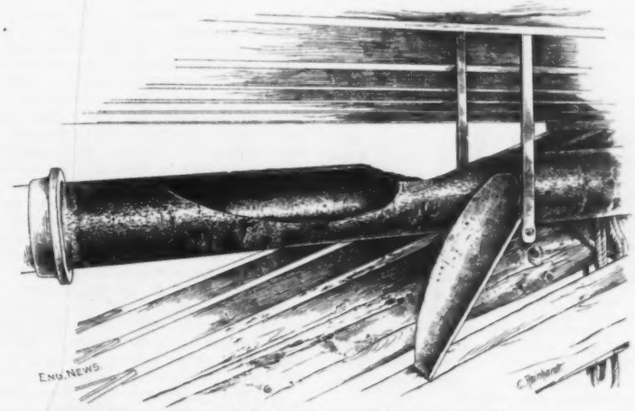
The "gravity flow system," then, amounts to this: That if it were possible to build an intercepting gallery of any great length parallel to the sea and delivering its water by gravity at Ridgewood, a possibility which we very much doubt, all the water that it would provide is simply that part of the annual rainfall now escaping to the sea through the soil, be this annual rainfall great or small. There would be practically no storage of water at all, and the rain that falls upon frozen ground and goes to the surface streams or depressions leading to the sea would be altogether lost. As compared with the present system of storing all the flood water possible and intercepting the seaward flow at some places between storage areas, the gravity system, as a substitute, is altogether insufficient in quantity and has but slight advantages in purity of supply.

It is well to remark here that some few advocates of underground water supply claim that because the voids in sand and gravel may amount to from 33 to 35% of the total volume they can secure a corresponding amount of water when this sand and gravel are saturated. The truth is that a quantity of water equal to about 10% of the total volume will remain in the mass to moisten it, and cannot be utilized as water supply. This is a self-evident point, but it is one frequently overlooked by the inexperienced in calculating underground water supply. Another point is that the uniformity of any water supply depends upon the maintenance of a permanent regime. Any upsetting of normal conditions in a case like that under consideration may for a time yield increased supply, but it will ultimately come back to the normal limiting conditions. One of the chief arguments in favor of the driven-well system is that in dry seasons it is possible to draw upon a certain amount of water stored within the underground cone of influence. But when this cone is exhausted you must wait for it to slowly fill up again. In other words, the supply from a gang of driven wells is not inexhaustible, as some of its advocates claim; for the limits of supply are again fixed by the same factors of hydraulic head and friction in the sand that establish the hydraulic grade line in the Long Island beds of saturated sand and gravel.

LETTERS TO THE EDITOR.

BREAK OF A CAST IRON WATER MAIN AT LOWELL, MASS.

Sir: The accompanying photograph represents, in situ, a length of cast iron water main which was ruptured on the night of Oct. 27, 1894, from the effects of water hammer. This main is part of the private system belonging to the proprietors of the locks and canals on Merrimac River, and crossed the Hamilton Canal under a bridge near the Lowell machine shop. The break occurred directly at this bridge. The main was being filled at the time of accident, and it is supposed that, owing to the crowning or camber of the main under the bridge, both sides filled before the crown; the shock from the meeting masses of water fracturing the pipe nearly at the highest point. The view shows the camber very clearly.



BREAK OF A SUSPENDED WATER MAIN AT LOWELL, MASS.

The fracture was about 6.1 ft. long and extended spirally about the pipe. When seen by the writer the sides of the fracture were so rusted that any evidence of a flaw, if any there was, was obliterated. The report was such that workmen in the vicinity thought that dualin, in use near by, had exploded. The normal pressure in this main is about 75 lbs. per sq. in.

Very truly yours, F. M. Goodhue,
Office Locks and Canals.

Lowell, Mass., Nov. 9, 1894.

RONEY STOKERS AT THE SPRECKLES SUGAR REFINERY.

Sir: A perusal by the writer of the well-collated and considered article on mechanical stokers in your issue of Aug. 9, has been delayed until now. In this article it is stated (p. 107) that at the Spreckles sugar refinery, in Philadelphia, a certain economy of operation by the use of the "Roney mechanical stoker" is had, as compared with simple hand firing. That such results were had and could have been continued I have strong reason to believe; but when I visited the boiler house of this refinery with its Superintendent two years ago, these stokers, although in place, were not in operation. Instead, the firemen were distributing the coal over the grate bars, by means of large pokers inserted in the peep-holes—a method intrinsically bad enough to cause any self-respecting and informed observer to turn his back. No satisfactory explanation was given by those in charge, or was perceptible from examination of the plant, for this curious and wasteful operation. The Superintendent was a new man, perceptibly not well disposed towards this style of mechanical stoking, as was made more evident when he exhibited a device of his own in operation under a single battery of boilers.

The incident is important as exhibiting how the well-

merited reputation of a superior mechanical device may be jeopardized by the action of an unfriendly manager.

Yours truly, L. G.

New York, Nov. 16, 1894.

A STANDARD BELL FOR CAST IRON PIPE.

Sir: In reference to the communication of Mr. Potter, in your issue of Oct. 25, I take this opportunity of indorsing the views therein expressed. My own observations and experience have led me to favor a shallow bell, and on our specials and gates during the past season we have used one only 3 ins. deep on all sizes up to and including 16 ins. The shallow bell requires less lead, and seems to lead to better calking, as less yarn is used. The effect of the yarn in a joint appears to be only temporary, so far as preventing leakage is concerned, for as it is a fibrous substance, the water does not work through it immediately; but after it has had time to become saturated, if the calking of the lead is not properly done, a line will be found leaking, that was tight on first test. Contractors are usually well up on this point, and as yarn can be rammed in more cheaply than lead can be driven, they will endeavor to get in an excess of yarn, hoping thereby to be able to slight the lead. As the lead in a joint is rarely affected by driving for more than 1½ ins. from the face, there is little to be gained by using more than 2 ins. of it. While our experiments have not been sufficiently extensive to fully demonstrate the point, yet they seem to indicate a saving of about 20% in lead for the 3-in. over the 4-in. bell.

Very respectfully yours, G. S. Williams,
Civil Engineer Detroit Water-Works.

Detroit, Mich., Nov. 8, 1894.

WATER SUPPLY UPON SANDY TIDE-WATER COASTS.

Sir: Engineering books and periodicals teem with every branch of inland water-supply questions, while little is said upon that subject applicable to tide-water coasts and similar formations, where the conditions differ widely, and only part of the inland system is applicable. Brooklyn having under consideration an extension of its water supply beyond Long Island, the question has the greater local interest at this time. And as it is applicable to thousands of miles of well-populated coast sections of the United States of similar formation, allow me to draw your attention to this subject by briefly advancing what seem to be the proper methods in the premises, with the object of drawing out your criticism, so that a distinct water-supply system applicable to such coasts may be defined and given standing by your authoritative journal.

Taking Long Island as an example of a usual sandy tide-water coast, we find that it is formed, particularly upon its seacoast side, almost exclusively of an immense bed of sand and gravel of great depth, which rapidly absorbs the rain as it falls. The lower saturated strata contain about one-third their bulk of water. The upper stratum or hydraulic slope rises from the shore tide level at an average of about 7 to 8 ft. per mile, the surface of this saturated bed, ten miles from the coast, being 75 ft. above tide level and about 125 ft. below the surface of the ground.

Thus Long Island is provided by nature with a filter bed 1,000 sq. miles in extent, about 100 miles in length and upon its seaward slope averaging ten miles in width, forming a reservoir of equal area, saturated as above named with water filtered not only through 2 to 5 ft., as in artificial filter beds, but for the most part through from 10 to 125 ft. of sand vertically, and through thousands of feet laterally. With the average annual rainfall of about 42 in., this immense reservoir stores and delivers at least 60% thereof, amounting per day to about 1,200,000 gallons per sq. mile, or a total of 1,200,000,000 gallons per day, which, if not otherwise utilized, flows into the sea.

Owing to the immense body of sand through which the water has to percolate, the outflow varies little throughout the year, being least about October—the month of least city-water consumption. The occasional flood rains serve to wash and cleanse the surface of this natural filter bed, carrying the impurities into the surface streams, which should, therefore, be excluded from all city and village water supplies. The theory may here be referred to, for discussion, that as microbes are by no means evils under all circumstances, but are found to be useful and necessary under certain conditions, it may be assumed that they act as scavengers in cleansing such natural filter beds, preventing their clogging with injurious matter, perhaps for all time.

So far, then, the conditions are almost perfection. We have filter beds, reservoir, purity of water, ample supply and even distribution throughout the year, all without the expenditure of a dollar. This is in great contrast with the usual inland conditions, where dependence is placed upon impure surface water, either basin-collected or from rivers; with dams, reservoirs, artificial filter beds, protection against the sun, etc., all involving great expenditures of money, and after all only partially attaining the results provided by nature free of cost upon such coasts. The question, then, is, By what method can nature's ample provision and storage of pure water in such localities be best utilized?

As above stated, the surface water in streams and rivulets should be excluded, unless it be drawn off through the underlying filter bed by the method outlined below. Two methods are available for collecting the underground water and conveying it, in this case, to the Ridgewood pumping station. One is "the driven well" system and the other "the underground gravitation flow" system. The driven well system, although inseparable from the costly necessity of pumping up the water, is favorably considered upon the erroneous assumption that by their location below the settlements, riparian rights are not interfered with; it being also erroneously assumed that the other, or underground gravitation flow-system, located among the settlements, is liable to deprive them of water. The reverse is the case, as follows: 1. All the water taken by driven wells, no matter where located, comes from the saturated bed above tide level (unless it comes from the sea, in which case it would be worthless), and therefore must draw upon the water, not only around the settlements which reach close down to tidal swamps, but upon all the country above it naturally drained in that direction. 2. The draft upon the saturated bed is not by natural percolation, as with the other system, but by forced suction, tending to prevent normal filling of the pumps, and apt to deplete the adjacent land and wells of all water. Moreover, as the tubes are usually driven to a considerable depth, as great as 90 or 100 ft., the neighboring wells have to be sunk below such depths to reach water. 3. This forcible suction is liable to draw upon surface contaminated water, which, under natural percolation, would remain undisturbed.

On the other hand, the gravitation system depends solely upon natural percolation. Perforated pipes or conduits are laid in the saturated bed, into which conduits all the water, for which they form the shortest outlet, must gravitate, the perforations being perhaps best made at the bottom. Such underground channels or galleries may be formed in various ways, the problem opening a considerable field for engineering ingenuity, the use of a driven shield seeming the most feasible plan. These conduits are laid as nearly parallel with the shore as the required grade may permit. Starting, for instance, at the Ridgewood pumping well, with 8 ins. fall per mile, the rise in 50 miles would be 33 ft., or still 42 ft. below the crest of the hydraulic slope. Were this slope of equal grade from the shore to its crest, this would bring the conduit about four miles inshore at its extreme end. But the grade being much more abrupt nearer the shore, the deviation from the shore line would probably be not over two miles.

This gives a drainage area above such a conduit of about 450 sq. miles, corresponding to about 540,000,000 gallons per day. Assuming that the water intercepted by the conduit bears the proportion to that escaping under it as the square root of their respective heads, or as $\sqrt{75}$ is to $\sqrt{\frac{75+42}{2}}$ so is 8.7 to 7.6. The available delivery of such a conduit appears to be over 470,000,000 gallons daily, which would flow by gravity to the Ridgewood pumping well. Upon the "driven well" system the water would have to be pumped, costing at least $8 per 1,000,000 gallons, amounting in a year to $1,372,400. This sum, at 3½%, represents an investment of $39,200,000, which sum represents the economy of this "gravity" system as compared to the "driven well" system, assuming that the plant and work of the latter would cost the same as the underground conduits required by the former. If more water is to be controlled, an offset could be made at the end of the first 25 miles, commencing the second 25 miles of conduit near the shore below the upper stratum of the hydraulic slope, the water obtained in the second 25 miles requiring to be conveyed to and raised by pumping into the first conduit connecting with the Ridgewood pumping well.

It is evident that anywhere along the line of such conduits a well sunk a little lower than the level of the water in the conduit cannot become dry. Nor can the hydraulic slope of the saturated sand bed above such conduit be lowered thereby any more than a corresponding approach of the seashore would do it; that is, there would be a corresponding shortening of the distance the water has to percolate through the sand to find its final level. It appears, therefore, that in every respect the natural or gravitation flow system has a decided advantage, in safety against infringement upon riparian rights, in purity of water, in abundant supply, in comparative constant supply throughout the year, in permanency and in economy. It is also made evident that Brooklyn, and all other cities within reach of a water supply from such coast formations as Long Island, need not look elsewhere for a water supply, which would be very costly, surface water only, and of precarious reliance. The gagings of the surface streams upon such coast formations cannot be relied upon as an indication of the underground flow of water to the sea, no more so than the measurement of the overflow of a sieve filled with water-logged sand could be depended upon as indicating the amount of water flowing through the sides of the sieve.

It seems appropriate in this connection to draw attention to the final necessity of using water meters in every house, not only because an excessive drainage of water from lands in need of it, to be wasted in cities, must finally be limited by law, but principally on account of economy. It is inexcusable to more or less deprive large sections of the country of their quota of water, to construct reservoirs and filter beds for its storage and purification, to pump it at a great expenditure of power, and then after incurring all the expense, to waste the most of it by reckless use and imperfect plumbing. Waste of water is almost everywhere on the increase, but seldom is a decrease reported. In Philadelphia its consumption has actually reached 200 gallons per head per day, at least 170 of which are wasted. Brooklyn has reached a maximum consumption of 90 gallons per head per day. As 30 gallons are ample for all legitimate use, two-thirds of the amount delivered is wasted, amounting to over 50,000,000 gallons per day. This is pumped at the auxiliary scattered stations at a cost of over $8 per 1,000,000 gallons, and again at the Ridgewood station at a cost of over $20, or a total of over $28 per 1,000,000 gallons. Now $28 × 50 = $14 per day, or $511,000 a year. At 3½% this represents an investment of $14,600,000. Adding to this the cost of the original supply of 50,000,000 gallons per day, about $1,000,000, the total investment in that wasted water is $15,600,000. On the other hand, 100,000 house meters with connections can be provided for $750,000, as good and durable as any made. Their inspection would cost about $33,000 per annum, and their maintenance and renewal $60,000; in all an annual outlay of $93,000, representing, at 3½%, $2,657,000. This, added to the cash outlay, gives a total of $3,407,000, as against $15,600,000. Thus to waste water costs over 4½ times as much, and that without taking into account the highly probable damages for infringement of riparian rights if the present system of supply is continued and extended, and the probable increase of waste. Water should be taxed at a low rate up to 30 gallons per head, to be paid for whether used or not. Then no sanitary plea of stint in water can be urged. The water used over and above 30 gallons per head should be taxed at a high rate, so that plumbing will be seen to and wanton waste absolutely prevented.

Robert Creuzbaur.

58 Broad St., N. Y. city, Oct. 23, 1894.

NOTES AND QUERIES.

S. inquires "the name of the most extended multiplication table in book form; if there is any larger than Taylor's, which extends to 550 × 1,000." We know of none larger.

A. F. asks whether engineers throughout the United States scale their drawings uniformly, and what scales are used by engineers and architects. There is no uniformity in scales of drawings except in the case of architects, who generally use a scale of ¼ in. to the foot for general drawings, and larger scales for details. Civil engineers prefer a decimal scale with the inch divided into 10, 20, 30, 40, 50, 60, 80 or 100 parts, and architects and draftsmen working on machinery use scales of ¼ in., ⅜ in., ½ in., ¾ in., 1½ ins., 2 ins., 3 ins., 4 ins. and 6 ins. to the foot.

HYDRAULIC POWER FOR WARSHIPS.*

The general scheme would be to have one general central pumping plant, from which would be delivered the necessary quantity of water at the same pressure (except so far as it might be reduced by fluid friction in the pipes) to all the various motors, the latter being of such types as might be found most suitable to the several operations to be performed. While this is not a new idea, it has, nevertheless, not yet been wholly carried out in any case, though many successful partial applications of hydraulic power have been made. But one of the greatest advantages of such a system, viz., the restriction of power steam pipes to the limits of the engine and boiler rooms, can only be realized by adopting some motive power other than steam for all auxiliary machinery outside those spaces; and the main purpose of this paper is to advocate the general adoption of hydraulic power for such machinery in the new vessels of our navy.

The production of the necessary hydraulic power is a simple matter of steam pumps. Where single applications of hydraulic power have been installed, as has sometimes been done in our new naval vessels, direct acting steam pumps of the duplex type have usually been employed. Such pumps are doubtless the best means to the end proposed in these particular cases; but for a more general and complete system of hydraulic power they are too wasteful of steam, and, in general, too uneconomical to be regarded favorably. It is proposed, therefore, to generate this power by economical modern steam machinery, of which the best type is to be found in the triple expansion engine. As the maximum hydraulic power will rarely be needed, and as for the larger portion of the time less than half that maximum will be re-

* Abstract of a paper read by Albert W. Stahl, Naval Constructor, U. S. N., at the recent annual meeting of the Society of Naval Architecture and Marine Engineers.

quired, it would probably be best to instal two complete and duplicate triple expansion engines, each competent to do half the total maximum work. The fluid best adapted to shipboard use is distilled water; and, as the exhaust water is returned to the supply tank and used over and over again, it is simply necessary to supply the small loss due to leakage. To avoid the danger due to freezing in hydraulic plants on shore, glycerine is sometimes mixed with the water, or mineral oil substituted entirely for the latter; but the actual conditions on shipboard are such as to render precautions of this kind unnecessary.

In most of the isolated installations of hydraulic power on shipboard, the power has been supplied by direct acting steam pumps, operating at a speed varying directly with the amount of power momentarily required. And for many purposes, such as the steering gear, this method leaves little to be desired. It involves, of course, pumps sufficiently large and quick-acting to produce promptly the maximum power that may be at any time required; they must start promptly as the demand for power is created, and stop just as promptly when that demand has been satisfied, and their speed in the interval must adjust itself automatically to the varying requirements of the case.

The choice of an accumulator for ship use seems to be practically limited to steam or pneumatic accumulators. In both these types the water is contained in a cylinder in which the piston works; the water pressure on the one side of this piston being usually balanced in the pneumatic accumulator by the air pressure on the other side of the same piston, and the steam accumulator by the pressure of steam on a larger piston in another cylinder, the two pistons in the latter case being rigidly connected. In the pneumatic accumulator the pressure of the air per square inch is thus usually, though not always, the same as that of the water, while in the steam accumulator the pressure of the steam is the pressure maintained in the boilers, or any desired lower pressure, according to the relative areas of the steam and water pistons. The exact water pressure can be more accurately maintained in a steam than in a pneumatic accumulator; but, on the other hand, the limits of variation of pressure in a pneumatic accumulator can be definitely fixed and the variation itself can be made sufficiently small to cause no practical inconvenience. The pneumatic accumulator seems, on the whole, the best type for ship use, needing practically much less attention than any other kind.

A good example of the pneumatic accumulator is shown in Fig. 1, as fitted on the "Monterey," in connection with the hydraulic turning gear for the turret of the 12-in. guns. It consists mainly of a heavy cast iron cylindrical shell A, 17 ins. internal diameter, forming the air chamber, into the top of which is fitted and secured the composition tube B, 6 ins. diameter, forming the water chamber. Within this tube works the piston C, separating the air space from the water space. The relative volumes of these spaces in this accumulator are as 11 to 1, and the normal pressure is 600 lbs. per sq. in. At the upper end of the water chamber is an opening D, connecting with the main hydraulic pipe. If the pumps are supplying water faster than it is being consumed the surplus enters the water chamber, forcing down the piston until equilibrium is re-established; meanwhile, the pumps are being slowed down by the mechanism operated by the end of the piston rod H. Any sudden increase in the demand for water causes the reserve water in the water chamber to enter the main hydraulic pipe; the piston rises and the motion of its piston rod starts, or increases the speed of, the pumps. The sudden fluctuations in the demand for water are thus met by increasing or decreasing the volume of the reserve water in the accumulator; and sufficient time is thus gained to gradually adjust the speed of the pumps to the new conditions of demand. A rubber buffer limits the stroke of the piston at each end. The opening E connects with a small air compressor, which is used for the purpose of originally charging the air chamber with air at the desired pressure and of replacing any slight leakage of air that may occur. Any water getting into the air chamber is drawn off through the drain pipe F. The pressure on both sides of the piston being the same, the amount of leakage in either direction is but trifling.

This accumulator has given very satisfactory results, and seems to be an excellent arrangement, where the volume of accumulated or reserve water is not very large. It is open to the objections that dry air under pressure is on one side of the piston packing, and that any leakage past the piston is internal and cannot be readily either detected or remedied.

In the "Oregon," a more powerful pumping plant was required for the turrets of the 13-in. guns; and to overcome the objections that might be urged against a sufficiently large accumulator of the type just described, an entirely different type of apparatus was designed, which is shown in Fig. 2. The air chamber A consists of a steel vessel supported and rigidly held by the two steel standards E and F. The main plunger consists of a composition tube B, open at top and closed at bottom, and firmly secured to the bed plate of the apparatus. C is an intermediate hollow plunger sliding on and properly packed against the outside of the main plunger B and the inside of the lower end of the air chamber A. The main hydraulic pipe connects with the lower end of the main plunger, at D. The area of the end of the intermediate plunger which is exposed to the air pressure being four times the area of the main plunger, it follows that the air pressure required in this accumulator is only one-fourth the water pressure. In this case, the water pressure is 600 lbs. per sq. in., and hence the air pressure is 150 lbs. per sq. in. The intermediate plunger is provided with two lugs, rising and falling on the standards and bringing up on springs at the bottom when descending with unusual rapidity; the motion of this plunger regulates the speed of the pumps. In the bottom of the air chamber a small amount of oil or water is kept for lubrication of the packing, the exact amount of such liquid present at any time being shown by the attached gage G. All leakage being external it can be readily detected and remedied. Instead of fitting a small air compressor for

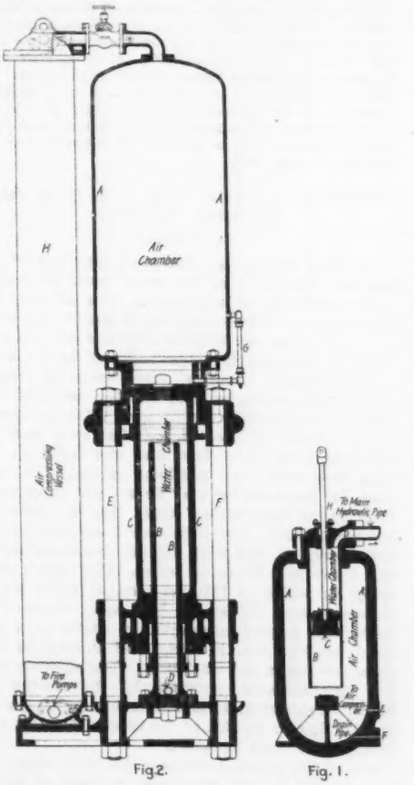


Fig. 2. Fig. 1.

Pneumatic Accumulators for Hydraulic Power Plant on the U. S. Warships "Monterey" and "Oregon."

originally charging the air chamber and replacing leakage, as in the other type of accumulator, this purpose is much more simply accomplished by means of the vertical air-compressing vessel H.

Neither of these types of accumulator is exactly suited to the conditions of the extensive general hydraulic system which is herein proposed. The air and water chambers must necessarily be very much larger, and the whole arrangement will thus occupy considerable space. It would seem, on the whole, best to make the main air chamber an entirely separate vessel, built of steel boiler-plate and connecting at the top by a large pipe to a small air chamber similar to that of the second type described.

For the transmission of hydraulic power from the accumulator to the motors a main supply pipe is led forward and aft from the accumulator, running along close up under the protective deck beams and gradually decreasing in size toward the ends of the vessel. This consists of heavy hydraulic pipe, with carefully made joints and easy curves. From this main pipe are run branches to the various motors, each branch being provided with a valve under the protective deck, as well as with a valve at the motor. The best valves for such purposes are the regular gate valves, which, when open, permit of a free passage of the water with the least possible obstructions. For the sake of economy, the supply pipes should be of such size as not to involve a speed of more than about 500 lin. ft. per minute for the water flowing through the same. For those motors which are not run continuously the advantages of a smaller size of branch pipe would outweigh the loss by friction thereby involved; but for the mains and for the branches for dynamos and blowers a rather large size should be fitted.

The exhaust or drain from the motors goes through branches to a main exhaust pipe, consisting of ordinary galvanized-iron gas pipe, considerably larger than the supply pipe, in order to give freedom to the drainage. This main exhaust pipe must have a general downward inclination toward the supply tank into which it empties. Sudden changes in the velocity of the water in these pipes, due mainly to the sudden starting or stopping of the motors or to sudden fluctuations in their speed will cause dangerously severe strains on the piping. It is therefore necessary to provide relief valves by which a sufficient amount of water can be automatically discharged when the pressure becomes excessive.

The same pumps, the same accumulators, and the same system of piping deliver the power to the various motors; but the motors themselves must be adapted in type and detailed design to meet the special needs of each particular operation to be performed. These various operations differ widely in speed, in direction, in frequency, in power, and in other ways. For example, the windlass requires a slow and powerful circular motion, usually in one direction, but requiring to be occasionally reversed; the dynamos require a uniform high speed in one direction only; the turrets require a very powerful circular motion with frequent and irregular reversals in direction and intervals of rest; the steering gear requires motion similar to that of the turrets, but in straight, or approximately straight lines only. Keeping in mind the principle above stated, that the normal speed of the motors should be, if practicable, equal to that of the machines, so as to obviate all intermediate gearing as much as possible, we may classify the various operations required in accordance with the three types of motors, which it is proposed to use, as follows:

1. Direct-acting Hydraulic Cylinders.—To be used for operations requiring motion in straight lines, or in a circular direction, provided that the motion is limited in amount. Under this head would come the steering gear, loading, elevating and running-in and out gear for turret guns, ammunition hoists, and the turning gear for the smaller sizes of turrets; also boat cranes, ash hoists, lifts for battle hatches, and other operations requiring definite and limited amounts of power and motion.

2. Hydraulic Engines.—To be used for operations requiring reversible circular motion of great power and moderate speed, and of more or less infrequent use. Under this head would come the turning gear for the larger sizes of turrets, the windlass, capstans, and winches.

3. Tangential Water Wheels.—To be used for operations requiring high speed, moderate power, and more or less continuous and usually non-reversible circular motion. Under this head would come the dynamos, the ventilation fans, and the blowers for forced draft.

Direct-Acting Hydraulic Cylinders.—Among the principal operations to be performed by direct-acting hydraulic cylinders is the steering of the ship; and we will begin with the consideration of this subject, especially as it can be spoken of as a satisfactorily accomplished fact rather than a proposed experiment. Of the five vessels built for the United States Navy by the Union Iron Works, of San Francisco, four have been fitted with hydraulic steering gear of the same general design.

The use of direct-acting hydraulic cylinders for various operations connected with the handling of turret guns and their ammunition may be regarded as a successfully accomplished fact, though but little has been done in our own ships in this direction. In the "Monterey," the guns of both turrets are elevated and depressed and run in and out, their ammunition is hoisted, and the guns are loaded by the direct action of such cylinders. The elevation of the gun is caused by the direct upward stroke of the piston rod of a vertical hydraulic cylinder; the loading arrangement consists of a telescopic hydraulic rammer, having its center line in the loading axis of the gun. The ammunition hoist needing considerable vertical motion, the short stroke of its hydraulic piston is multiplied by means of ropes and sheaves. The hydraulic cylinder by which the gun is run in and out also acts as a recoil chamber. The whole installation seems to be giving good satisfaction.

While the ammunition hoists for some of our turret guns have been successfully operated by means of direct-acting hydraulic cylinders provided with multiplying sheaves, those for the smaller guns not in turrets are still operated by hand or by electric power. Thus the ten 5-in. guns on the main deck of the "Olympia" are supplied by means of twelve hoisting

chutes, four being located forward, amidships, and aft respectively. The ammunition is hoisted by endless chains actuated by electric motors, each chain operating two adjacent chutes. This arrangement could be advantageously replaced by a system of direct-acting hydraulic cylinders, one for each chute, located under the protective deck, and operating by means of multiplying sheaves.

The required partial revolutions of the turrets could be readily caused by direct-acting hydraulic cylinders; and this arrangement has, in fact, been proposed by Mr. Geo. W. Dickie, Manager of the Union Iron Works. This proposed arrangement does not seem advisable for the larger sizes of turrets, the power for revolving which must always necessarily be applied to a circle of considerable diameter. For such turrets, hydraulic engines would probably be preferable; and such engines have, in fact, been very successfully employed under these circumstances. For smaller turrets, however, such as the 8-in. gun turrets of the "Olympia" and "Oregon," there seems no reason why direct-acting hydraulic cylinders should not be used. These turrets are at present revolved by a strong vertical steel turning tube about 3 ft. diameter, protected from injury by being surrounded by a fixed armored tube extending from the armored deck to the base of the turret. The turning tube is secured to the floor of the turret, so as to turn with it, and extends downward below the armored deck, being driven at its lower end by worm gearing actuated by a local steam engine. This whole steam-turning gear could be very advantageously replaced by two horizontal direct-acting hydraulic cylinders, secured to the under side of the armored deck on opposite sides of the turning tube, and having their center lines parallel and tangent to a circle a little larger than the diameter of that tube. The outer end of each piston rod would be provided with sheaves to multiply the motion, wire ropes secured to a fixed point being led over the sheaves, then partially around the turning tube, and finally fastened to the dead space on the latter.

Many other uses of direct-acting hydraulic cylinders would readily suggest themselves in carrying out a comprehensive hydraulic system. Such cylinders can often be advantageously fitted where lack of space or close work forbids the use of other and more cumbrous devices. For lifting the heavy-armored battle hatch covers of the "Monterey" and "Oregon" a simple hydraulic cylinder is fitted close under the deck; its piston rod has a rack cut on its outer end; this rack gears with a toothed sector on a shaft lying parallel to the line of hinges.

Hydraulic Engines.—While many operations on shipboard may be advantageously performed by means of hydraulic engines, yet, by far their most important use is to be found in the training of turret guns by the actual revolution of the whole turret. Especially is this the case with the larger calibers of guns, where the weights are too heavy and the diameters of the turrets too great to permit of the satisfactory use of any other motive power. The 10-in. and 12-in. gun turrets of the "Monterey" have been, and the 13-in. gun turrets of the "Oregon" are being, fitted with hydraulic turning gear of the same general design. The whole apparatus may be briefly described by stating that two hydraulic engines are secured to the floor of the turret, which, by means of pinions gearing with a toothed rack on the lower and fixed roller path, drive the turret in either direction.

There are several other important operations to which hydraulic engines are well adapted. Among these are the windlass or anchor-hoisting gear, winches and capstans; and the fact that these operations are performed at great distances from the engine rooms renders the use of hydraulic power in this connection specially valuable, giving us not only all the simplicity and other inherent advantages of this power, but avoiding the inconvenience and danger attending the carrying of steam to these remote points. The first formal sanction to the use of the hydraulic windlass in our navy was given in the specifications for battleships Nos. 1 2 and 3, which require a "steam or hydraulic" windlass to be fitted; but no windlass of the hydraulic type has yet been actually installed in any of our ships.

Tangential Water Wheels.—There is a third class of operations on modern warships, the general characteristics of which are high speed, moderate power, non-reversibility of direction, or at least reversibility at long intervals only, and more or less continuous operation for considerable periods of time. In this group we have the dynamos, the fans for ventilation and the blowers for forced draft; and these it is proposed to drive by tangential water wheels. The proposed motor is one that is well known on the Pacific Coast. A wheel, mounted on a central shaft provided with two suitable bearings, has secured to its rim a number of buckets closely spaced. The water, under high pressure, is led to the wheel in a suitable pipe, and is discharged, through a conical nozzle with a cylindrical tip, in a tangential direction against the buckets. So long as the water pressure is constant, and there is no variation in the load, these wheels will run with absolute uniformity of speed without any attention except occasional oiling of the two bearings. Any variation in either of these two factors will of course involve a proportionate fluctuation in the speed. For most of the contemplated operations, however, such slight fluctuations of speed are a matter of little or no importance; the blowers, for instance, will work just about as satisfactorily whether they run steadily at 500 turns or whether the revolutions at times vary 25 or 30 either way.

But there is one class of naval machinery that would be, more than any other, benefited if such wheels could be used for its motors, where more than an extremely slight fluctuation of speed is entirely inadmissible, and that is the electric-generating machinery. In addition to being the class where fluctuation of speed is most objectionable, it is likewise the class where variation of load is most frequent and most considerable, and where such variation occurs with the least warning.

Another use to which this motor would be well adapted would be as a substitute for a steam engine in driving the various tools in the engineer's workshop. For this purpose, as the number of tools in operation, and consequently the required power, would vary, it might, for the sake of economy, be advisable to resort to the system of multiple nozzles, which has been adopted for many purposes on shore. Instead of fitting a single nozzle of sufficient size to give a jet capable of generating the maximum power, we would arrange three nozzles behind one another, so as to deliver into different buckets, each nozzle giving ⅓ that total power. By this means we could at will use 1, 2, or 3 nozzles, giving ⅓, ⅔ or the total power. Another plan would be to dispense with a general motor entirely, and fit a separate wheel of the proper size and speed to each individual machine tool.

TORPEDO LAUNCH FOR THE U. S. BATTLESHIP "MAINE."

(With inset.)

We show on our inset this week drawings of the hull and machinery of one of the most interesting little vessels in our new Navy. It is officially designated as a "Third-class Torpedo Boat"; but, since it is carried on the decks of a man-of-war, its real character is probably better indicated by the term torpedo launch. Four of these boats of similar construction are to be built, two for the battleship "Maine" and two for the "Texas." The machinery for the boats for the "Maine" has been built at the New York Navy Yard, and was tested on the shop floor with very gratifying results. The engines for the boats for the "Texas" are under way. It is one of the "Maine" boats that is shown on our inset sheet. The little vessel measures 61 ft. 8 ins. over all, has 9 ft. 1½ ins. beam amidships and draws only 26 ins. of water. Her total weight ready for service is 15¾ net tons, of which about 3 tons is coal and stores. To equip so small a craft with a quadruple-expansion engine is a decided novelty, and, in fact, chief interest in the vessel centers in her machinery. The specifications for the machinery, prepared by the Bureau of Steam Engineering, form a pamphlet of 39 pages, which will give an idea of the care with which the launches are being equipped.

One of the principal duties of the little vessel, in fact, practically her only work, in times of peace, will be for despatch service, and it is for this reason she has been given very powerful but economical engines and is fitted to run in heavy seas by a high freeboard and great stability. The frames of the hull are chiefly of angle-irons. The boat is decked over for its whole length, save between frames 14 and 19 and frames 39 and 47; these spaces form water-tight cock-pits for the use of the crew. The hull is divided transversely by six bulkheads, forming seven water-tight compartments. Fore and aft trimming tanks are provided.

The vessel's weapons are a bow torpedo tube and a 1-pdr. rapid-firing gun, mounted at the stern. At the rear the torpedo tube extends into a small tower, in which the pilot is posted. The chamber for loading the torpedo tube is immediately below this tower and back of the collision bulkhead. Aft of the tower is a cock-pit with a provision bin below it and a fresh-water tank on each side, from which the boilers are supplied.

The boiler compartment can be closed air-tight for working with forced draft and a ventilating pipe with large cowl supplies air for natural draft. The engine compartment is back of the boiler-room and separated from it by a tight bulkhead. This room can also be closed air-tight when desired, and is then lit by a deck light. The coal bunkers are on each side of the boiler and engine rooms, and water-tight doors connect the bunker space beside the engine-room and that beside the boiler-room. The ammunition department is behind the engine room and communicates with the rear cock-pit by a water-tight door. The rudder can be worked by a tiller in the rear cock-pit, in case the ropes from the pilot tower should break or foul. The little vessel can be manned by a crew of five, a commander, a machinist, a fireman and two sailors for working the torpedo tube and the gun.

The Whitehead torpedoes weigh in all more than 2,100 lbs., and as this weight is placed rather high above the waterline, it had to be counteracted by placing the heavy machinery as low as possible. The stability of the boat when ready for action, with torpedo, munitions and crew, is as follows:

Metacentric height, ins.	18 19-32
Inclination at greatest stability	43°
Inclination at limit of stability	89°
Moment at greatest stability, ft. lbs.	27,135

The very high boiler pressure of 250 lbs. was adopted, and it was decided to keep down weights by the use of a tubulous boiler. The boiler of Mr. C. D. Mosher was the one adopted. As installed in this little vessel it consists of two upper and two lower horizontal cylinders, connected by 440 drawn steel tubes 1 in. in diameter and of a thickness corresponding to No. 15 B. W. G. The boiler can develop 200 to 250 HP. under forced draft. It has 13 sq. ft. of grate surface and 513 sq. ft. of heating surface. The boiler is covered with a heavy jacket of asbestos, with felt inside, and the furnace fittings are shielded by fire-brick and asbestos packing. The covering is put on in sections to permit easy access for inspection, and there are openings in the front plate, through which the tubes may be cleaned by a brush or a steam jet. Several blocks of zinc are fastened in both upper and lower drums, connected to each other by iron bars and each connected by a copper wire to the boiler plates, the object being, of course, to prevent corrosion.

A flap damper is hinged in the ashpan in such a way as to permit free entrance of air, but to close automatically in case a sudden outrush of steam should occur from the bursting of a tube, and thus prevent blowing the fire out into the boiler-room.

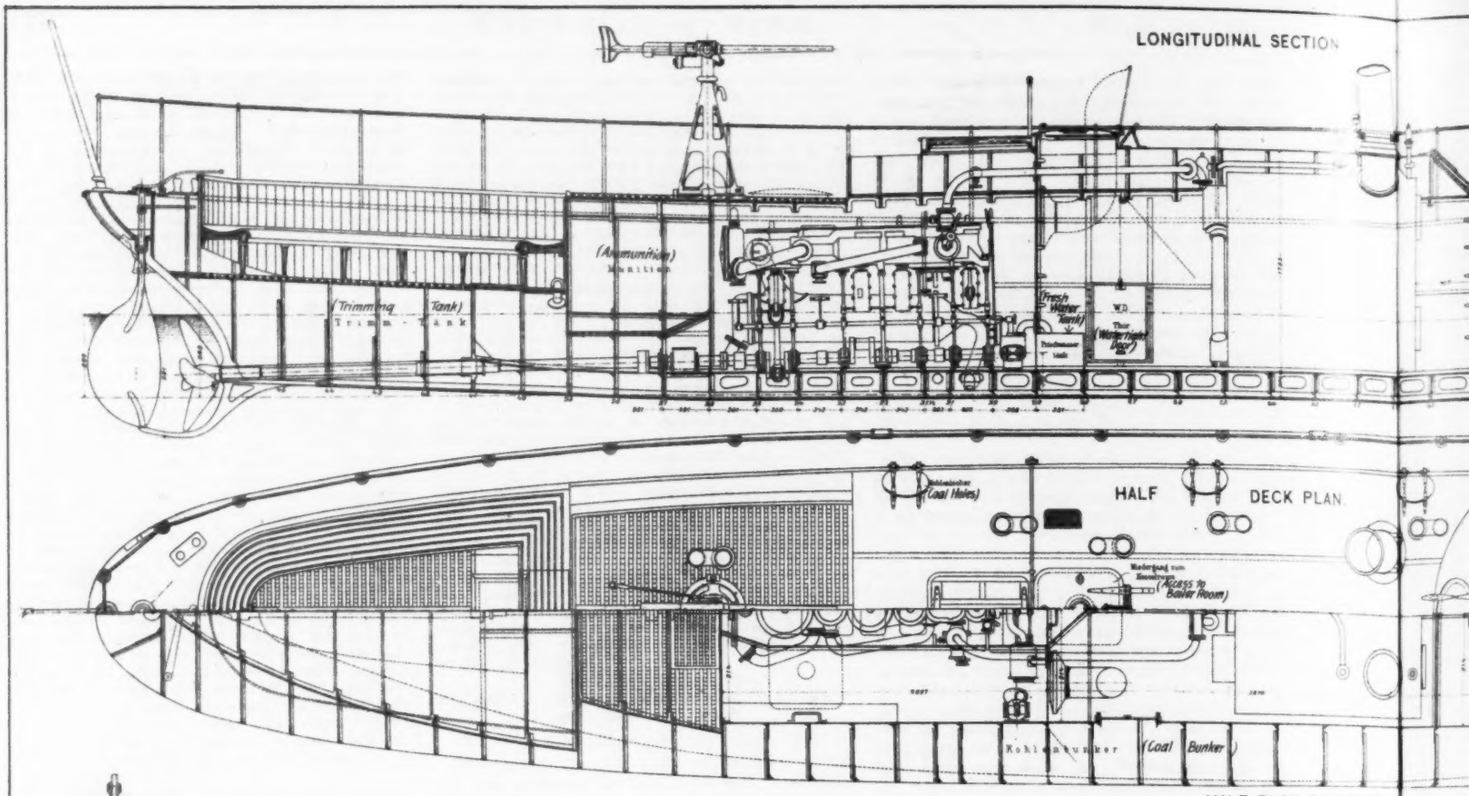
Our inset sheet shows the engine in detail. It is designed to develop about 200 HP. with 250 lbs. of steam when making 675 revolutions. Piston valves control the steam supply, except to the low-pressure cylinder, where a double-ported slide valve is used. The cranks of the h.-p. and first intermediate cylinders are placed directly opposite each other and the reciprocating parts connected with opposite cranks are given exactly the same weight to lessen vibration. The same thing is done with the other two cylinders. The l. p. and first intermediate pistons are of forged steel. The other two pistons are cast iron. Each piston has two 5-16-in. packing rings of cast iron.

The condenser is entirely of composition and has about 150 sq. ft. of cooling surface. The vacuum is maintained by two single-acting air pumps, driven by gearing from the forward end of the main shaft. The circulating pump is of the centrifugal type, but is only designed to take care of steam blown off when the boiler is idle. When the vessel is in motion, the circulation is maintained by scoops over the injection and the outboard delivery.

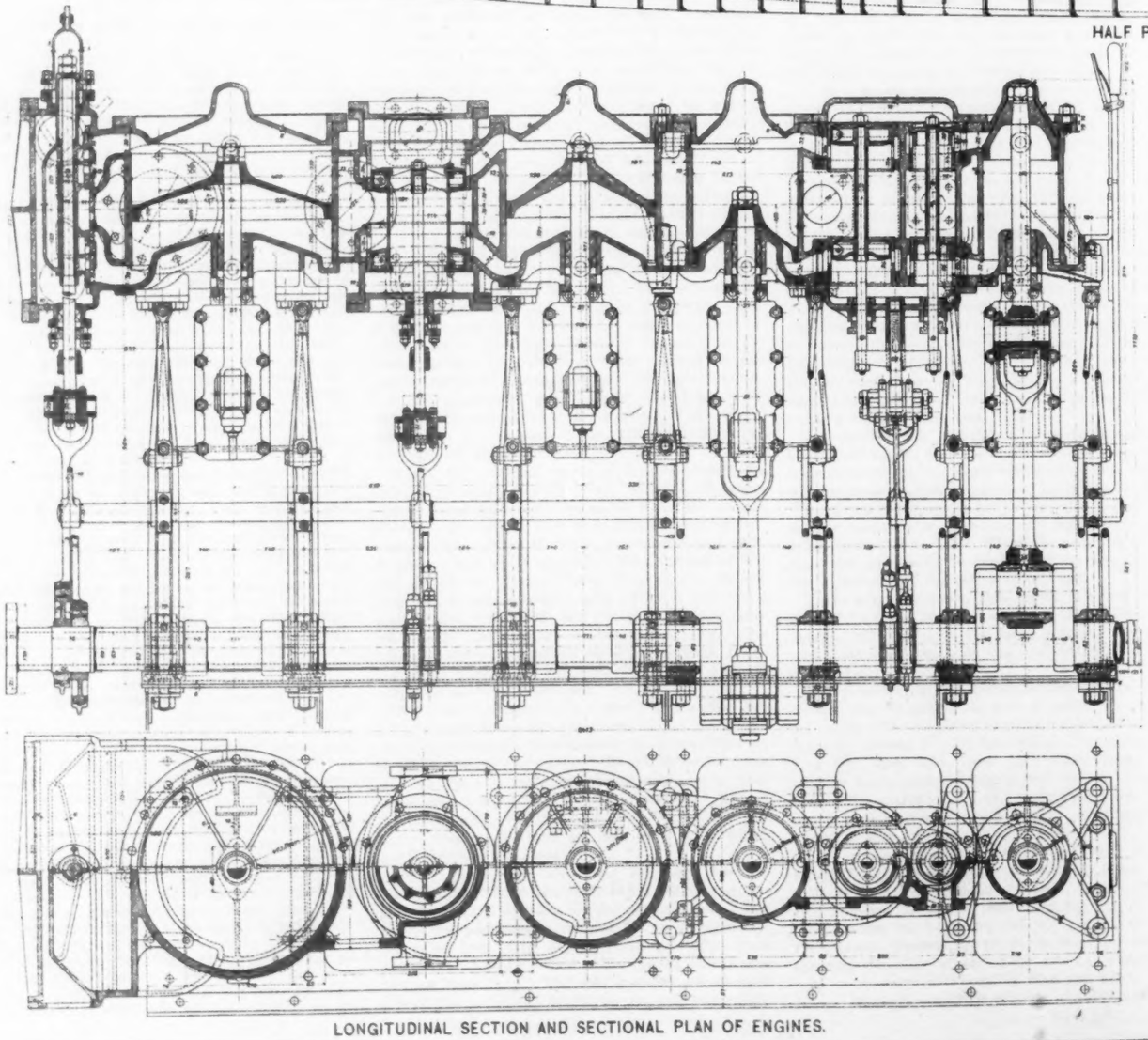
There are two smoke pipes, each 11½ ins. inside and 12 ft. 6 ins. above the grate. These pipes are double, with a 1¼-in. air space between the outer and inner shell, open at top and bottom for free circulation.

The propeller is composition metal, 36 ins. in diameter and 39 ins. pitch, with a helicoidal area of 4.1 sq. ft. The propeller shaft is hollow, 3 ins. in 2 diameter outside and 2¼ ins. inside. The stern tube is a 4-in. steel tube, lined with white metal, and with a hemp-packed stuffing box in the forward end. The shafts are all of forged mild steel. The piston rods and valve stem are of mild steel, oil-tempered and ground.

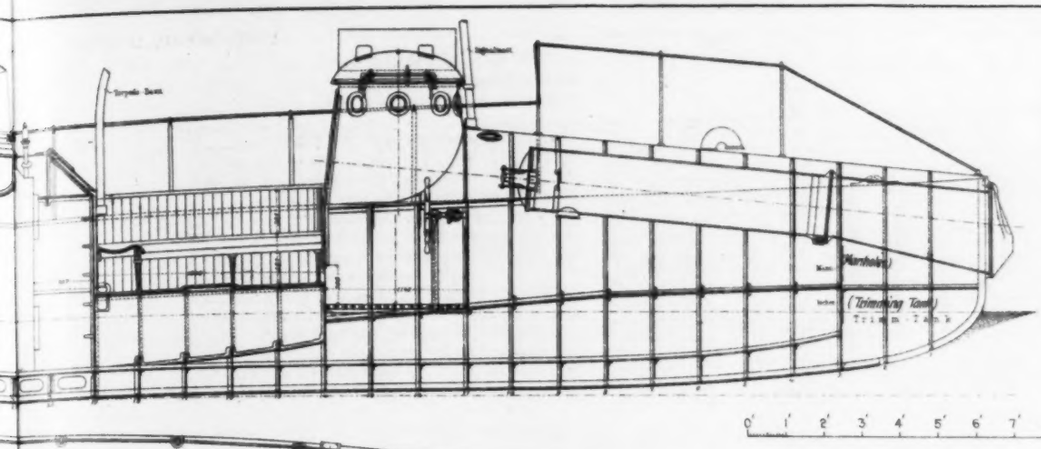
The smallest engine on board the vessel is that which drives the centrifugal circulating pump. Its cylinder is 2 ins. in diameter and 1¼ ins. stroke. For keeping the bilges clear, the suction of both feed pumps can be connected with the bilge, and there is also a steam ejector in the fire room leading through the side of the boat at the water line with a capacity of about 11 tons per hour. The blower in the fire-room is capable of supplying suffi-

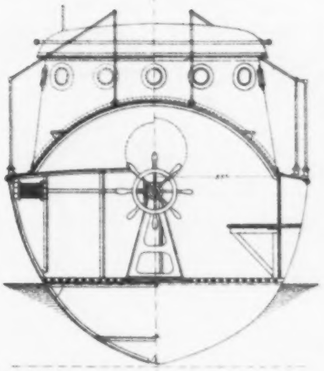


HALF PLAN OF HOLD.



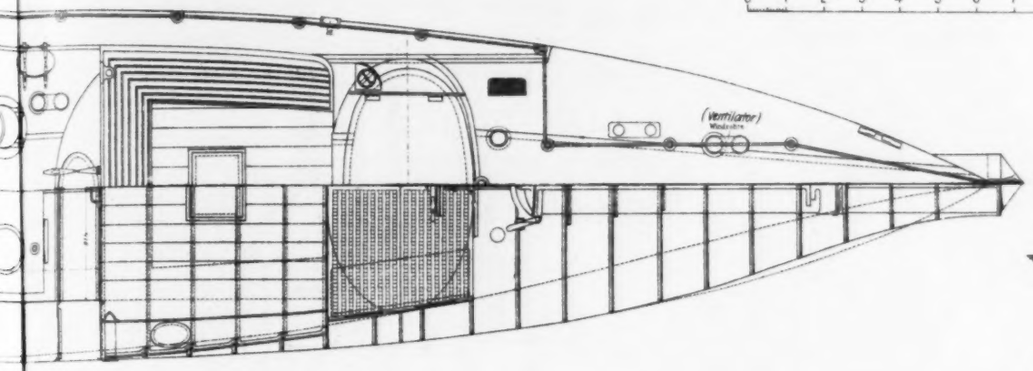
LONGITUDINAL SECTION AND SECTIONAL PLAN OF ENGINES.

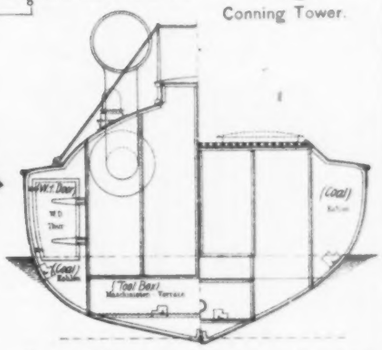




Back of Frame 11.

Through Conning Tower.

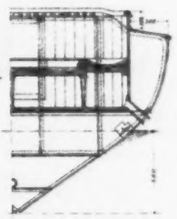




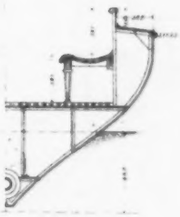
Front of Frame 29.

Front of Frame 36.

At Collision Bulkhead.

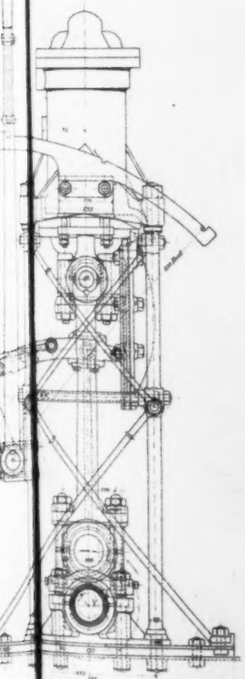


Back of Frame 39.

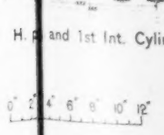


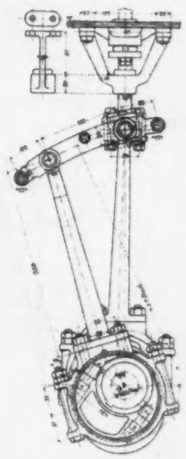
Front of Frame 41

CROSS-SECTIONS OF VESSEL.

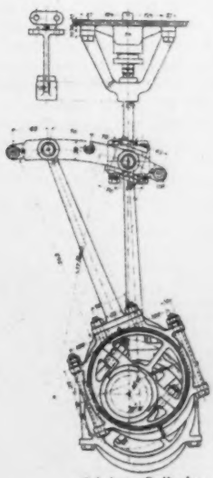


H. P. and 1st Int. Cylinders.



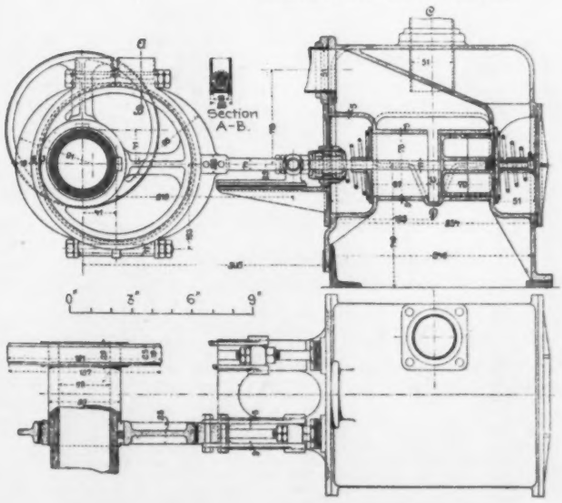


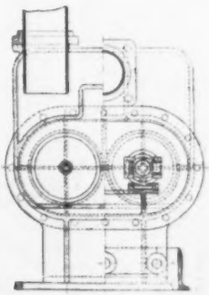
L. p. Cylinder.



2d Int. Cylinder.

DETAILS OF VALVE GEARS.





Section C-D.

DETAILS OF AIR PUMP.

THIRD-CLASS TORPEDO BOAT WITH QUADRUPLE-EXPANSION ENGINES FOR THE U. S. BATTLESHIP "MAINE."

Designed by the Bureau of Steam Engineering, U. S. N.
Commodore Geo. W. Melville, Chief of Bureau.

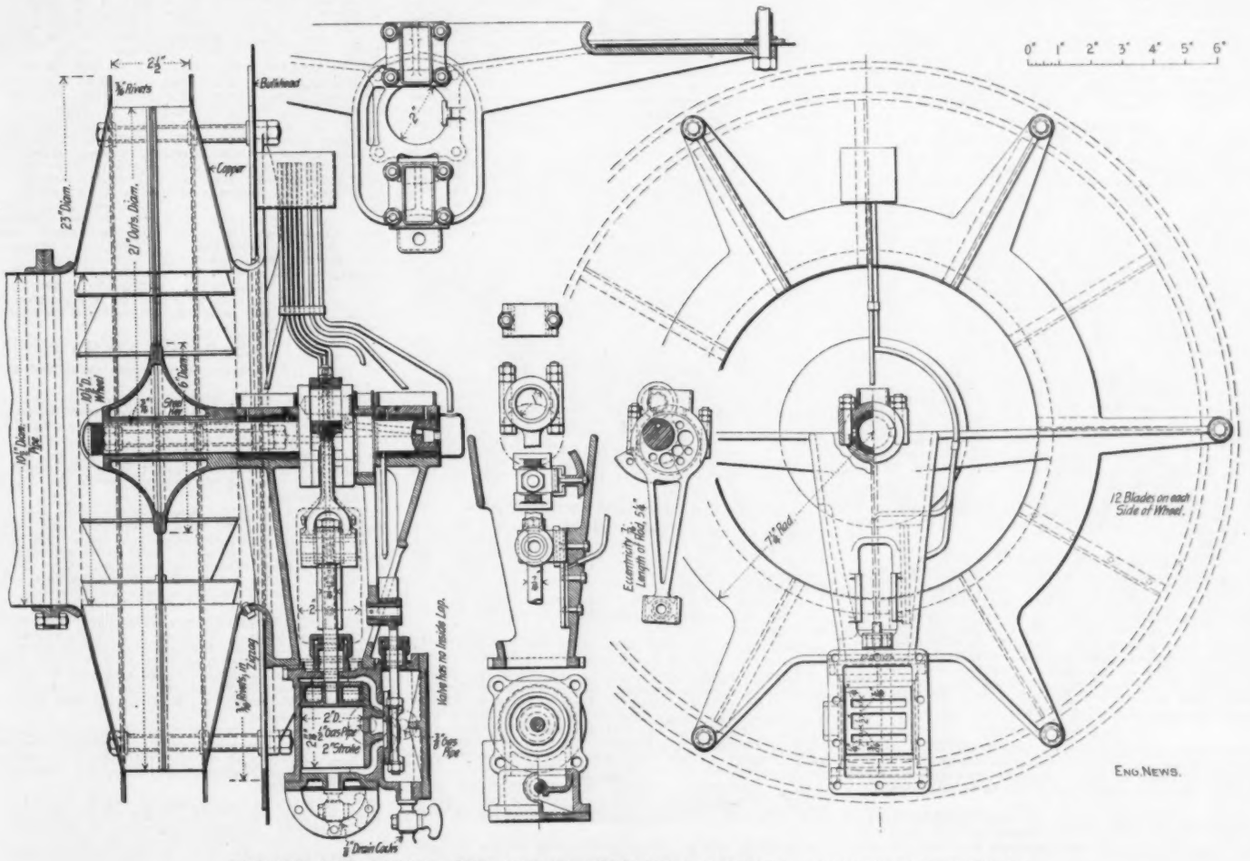
CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

cient air to burn coal at the rate of about 720 lbs. of coal per hour. The engine-room and fire-room are floored with 1-16-in. iron plates, with flat-topped corrugations.

The specifications required the boiler, high-pressure cylinder and valve chest to be tested under 340 lbs. per sq. in., hydrostatic pressure. For the condensers and exhaust side of the low-pressure valve chests 30 lbs. test pressure is required. India-rubber valves, taken at random, must stand a dry-heat test of 270 ft. for one hour and a moist heat test of 400° for three hours without injury.

The boat is expected to attain a speed of 18 knots with the engines developing 200 HP. At a fuel consumption of 1⅞ lbs. per HP.-hour, which, it is claimed, the engine can attain at full speed; this would mean a consumption of about 333 lbs. per hour, and the bunker supply would permit a full-speed run of about 120 miles. At an ordinary cruising speed of, say, 10 miles per hour, it is expected that the coal consumption per horse power will be still lower, and that the vessel will be able to make some 400 miles without recoaling.

The drawings of the vessel and machinery, which are shown on our inset sheet, we have reproduced from the proceedings of the Society of German Engineers. We are indebted to Commodore Geo. W. Melville, Chief of the Bureau of Steam Engineering, for the drawing from which our illustration of the blower and blower engine is reproduced.



BLOWER AND ENGINE FOR USE IN TORPEDO LAUNCHES "MAINE" AND "TEXAS."

A 10-ft. reflector telescope, with a length of 80 ft. and a weight of nearly 100 tons, is being discussed in London. Sir Howard Grubb, the well-known telescope maker of Dublin, is said to have already made plans for such an instrument for unknown parties and puts the cost at about $150,000. The material for the reflector is not decided upon; he prefers silver in chemical solution deposited on the face of the glass in an extremely thin film; and if this should fail, then one of speculum metal could be used. The mounting of such a mirror presents the chief difficulty, on account of its enormous weight. It is proposed, however, to float it in an enormous tank of water, 60 ft. in diameter and 100 ft. high. By this means the friction of motion would be practically eliminated.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BOSTON & MAINE.—A press report from Northampton, Mass., states that the problem of the separation of the grades of the Boston & Maine and New York, New Haven & Hartford railways from those of the highways, which has been under discussion for four years, was practically solved Nov. 15 by the presentation of plans agreed upon by the officials of both railway companies and Mayor Kimball and their approval by the city council. The total cost of the proposed change is $750,000, and the work will be commenced next spring. The tracks have been raised and the streets slightly lowered at each of the seven crossings. Iron bridges will cross the highways. A new union depot to cost $70,000 will be built, and all the freight yards and depots of the two roads will be removed to the north end of the city.

CENTRAL COUNTIES.—This railway has been graded from Rockland, on the Canadian Pacific, to South Indian, Ont., on the Canada Atlantic, a distance of 17 miles, and it is stated that the rails will be laid immediately.

CENTRAL OF NEW BRUNSWICK.—It is reported that this railway will be extended about 15 miles next season to Queens county coal fields, and eventually to Fredericton, 45 miles.

CINCINNATI, UNION CITY & CHICAGO.—G. W. Patchel, Secy., Union City, Ind., writes us that 17 miles of this railway are graded and bridged ready for the rails and that the president writes that arrangements have been made for placing the bonds so that the construction can be resumed soon. The right of way is about all secured. Bracey Bros. & McNair, Chicago, are the contractors.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS.—Geo. W. Kittredge, Ch. Engr., Cincinnati, writes us as follows: I am at a loss to know where the newspapers got the information that the Big Four is to build an independent line into Louisville. It has not yet been decided that any such line will be built. ——A press report of Nov. 17 from Wabash, Ind., states that S. T. Blizard, of that city, Supt. Michigan Division, said that morning that the extension of that division to Louisville had been decided on and that the trains would be running over it the coming spring; also that the company has splendid terminals in Louisville, the right of way through Jeffersonville, and that part of the roadbed between North Vernon and Louisville is graded. With pleasant weather most of the work can be done in four months, and the Big Four will then have a line between Cincinnati and Louisville, via Greensburg, only 10 miles longer than the Baltimore & Ohio Southwestern, and 30 miles longer than the Louisville & Nashville.

COAST RY. OF NOVA SCOTIA.—Bids are asked until Nov. 30 for 280,000 ties and 100,000 fence posts; also for the construction of 90 miles of fencing. A. H. Chadbourne, Supt. Construction, Lovitt Bldg., Yarmouth, N. S.

INTERCOLONIAL.—Bids are asked until Dec. 3 for the construction of branch lines of railway as follows: Grading from Windsor Junction to Station 290, 5½ miles; and from Tufts' Cove, Dartmouth, N. S., via Lake William to Station 290, 5 miles. D. Pottinger, Gen. Man., Moncton, N. B.

OTTAWA, ARNPRIOR & PARRY SOUND.—It is reported probable that contracts will be awarded this winter for the extension from Long Lake to Emsdale, Ont., 60 miles, for which surveys are now being made. Ch. Engr., G. A. Mountain, Ottawa, Ont.

PENNSYLVANIA.—Wm. H. Brown, Ch. Engr., Philadelphia, writes us that surveys have been made, line located and about three-fourths of the right of way secured for the Elkton & Middletown road. The route is from Elkton, Md., to Middletown, Del., by way of Chesapeake City, 13 miles, and about 1,000 ft. through Elkton has been graded. Nothing has been done south of Elkton. Jacob Tome, Port Deposit, Md., is president of the Elkton & Middletown.

WEST VIRGINIA CENTRAL & PITTSBURG.—F. A. Parsons is in charge of a party making a reconnaissance for an extension of this railway from Elkins, W. Va., up Cravins Fork and Shaven's Fork to the Cheat bridge and thence across the mountains to the Greenbrier River to the Pocohantas mines in Virginia.

Projects and Surveys.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—E. N. Talbott, Pres., 119 Lasalle St., Chicago, writes us that surveys have been completed, right of way practically secured and also ground for 11 stations and side tracks. About $100,000 has been voted to the company by townships through which the line will pass. Some grading has been done near Indianapolis, but the contract for the construction has not been awarded. The road will be 75 miles in length. Ch. Engr., W. A. Osmer.

PORT HURON & LEXINGTON.—Edgar H. Brennan, Ch. Engr., Toledo, O., writes us that this railway is projected from Port Huron, Mich., along Lake Huron beach to Lexington, Mich., 20 miles. The line has been surveyed and located and the right of way and large local aid and a valuable franchise in the city of Port Huron have all been secured. The capital for the construction has not yet been obtained. Steam will probably be used for motive power.

Southern—Existing Roads.

ATLANTIC SHORT LINE RY.—A correspondent writes us as follows: This company is the successor of the Macon & Atlantic, which was organized to build a line from Macon, Ga., to Colleton, S. C. About 12 miles of track was laid and about 60 miles more graded several years ago. It is now proposed to complete the line at once from Bruton, Ga., to Stillman Ga., and it is reported that trackiaying has already been commenced near Bruton. Pres., John R. Young, Savannah, Ga.

BALTIMORE & OHIO.—Press reports from Cumberland, Md., state that this company has purchased 25

acres of land in South Cumberland and will build a roundhouse and machine shop.

EAST AND WEST OF ALABAMA.—A correspondent writes us that this railway has been purchased by the Columbian Equipment Co., New York, which has also purchased the Highland Ave. & Belt road of Birmingham, Ala., and will use it as a terminal for the proposed extension of the East & West into that city. The road extends from Pell City, Ala., to Cartersville, Ga., 117 miles, and press reports state that it will be extended to Birmingham and also to Atlanta or Elberton, Ga. The Columbia Equipment Co. is reported as owning the Chattanooga Southern and about to extend it to Gladstone, Ala. The Seaboard Air Line is reported as probably interested.

FLORIDA CENTRAL & PENINSULAR.—A branch from Summerfield to South Lake Weir, Fla., seven miles in length, will be built as soon as the surveys are completed, according to reports. Ch. Engr., B. Burwell, Jr., Jacksonville, Fla.

MOBILE & OHIO.—It is reported that Monroe, Strang, Lee & Co., New York, have contracted to build 200 miles of railway for this company, including a line between Montgomery and Tuscaloosa, Ala.

STILLMORE AIR LINE.—We are informed that surveys are being made by Arthur Pew, Ch. Engr., for an extension of this line from Stillmore, Ga., to Swainsborough, Ga., a distance of about 13 miles. The line is through a timbered country, and its principal freight will be lumber, naval stores, cotton, fertilizers and general merchandise. The grading and trestling will be light and there will be no briuges. The company at present has 20 miles in operation, from Stillmore to Collins. Pres., Geo. M. Brinson, Stillmore, Ga.

Projects and Surveys.

BRYSON.—F. S. Paddock, Bryson City, N. C., wants to purchase second-hand 25 to 30-lb. steel rails in good condition; also a second-hand transit and level to run and keep up 8 or 10 miles of logging railway.

HINTON & NEW RIVER.—We are informed that preliminary surveys have been made and the right of way is now being secured for this railway from Hinton, W. Va., on the C. & O., to mouth of East River, Glen Lyn station on N. & W., a distance of 31 miles. A portion of the capital has been secured, and several propositions to issue bonds to aid the road will soon be voted upon. The location will be made in December and the construction is expected to commence soon thereafter. The principal office is at Hinton, W. Va. Pres., Jas. T. McCreery, Coal Gate, W. Va.; Ch. Engr., R. H. Kello, Radford, Va.

PENSACOLA & NORTHWESTERN.—S. N. Van Praag, Pres., Demopolis, Ala., writes us that surveys have been made from Pensacola, Fla., to Eutaw, Ala., 220 miles, and about 200 miles of right of way secured. Contracts for the construction will be let within the next four weeks. The projected length is 432 miles, and Mr. Van Praag states that the public necessity for this road is great and it will be built, as everything points to an early securing of all the capital needed for the construction.

PICKENS.—The American Engineering Co., Atlanta, Ga., is reported to have been awarded the contract for building this railway from Pickens, S. C., to Easley, S. C.

Northwest—Existing Roads.

DAKOTA, WYOMING & MISSOURI RIVER.—Wm. T. Coad, Pres., Rapid City, S. Dak., writes us that eight miles of this railway west from Rapid City has been completed and equipped, and that the construction will be resumed about Jan. 1. The road will be 350 miles in length and connect Chamberlain and Rapid City, S. Dak., with the Skull Creek coal fields in Wyoming. Most of the right of way has been secured and most of the grading and bridging through the Black Hills has been completed. Over $400,000 has already been spent on the work.

Projects and Surveys.

CHICAGO, YANKTON & SOUTHWESTERN.—J. R. Hanson, Pres., Yankton, S. Dak., writes us that nothing will be done on this road until next spring. The route is from Yankton through Akron to Le Mars, Ia., 70 miles. Ch. Engr., A. K. Nash.

HARLAN, SIOUX CITY & NORTHERN.—O. P. Wyland, Pres., Harlan, Ia., writes us that this railway is projected north from Harlan, Ia., but will not be built until 1895.

PELLA & NEW SHARON.—C. H. Byers, Oskaloosa, Ia., made preliminary surveys and estimates for this railway last spring, and we are informed that Leston McMillan, Pres., is trying to get the Iowa Central to back the enterprise. The road is projected from Oskaloosa, by way of Pella, to Howell, Ia., 23 miles.

RANDOLPH COUNTY.—Incorporated in Illinois to construct a railway from a point on the main line of the Centralia & Chester, at Sparta, to a point at or near Percy; capital stock, $50,000; incorporators, H. W. Schmidt, E. A. Burrill, B. F. Stillison, R. J. Goddard and D. P. Barker, all of Sparta, Ill.

Southwestern—Existing Roads.

FORT WORTH & RIO GRANDE.—This railway is in operation from Fort Worth to Brownwood, Tex., 142 miles, and it is reported that the line will soon be extended from Brownwood southwest to the Colorado River. Ch. Engr., W. B. King, Fort Worth, Tex.

GULF, BEAUMONT & KANSAS CITY.—W. C. Averill, Secy., Beaumont, Tex., writes us that 42 miles of this railway are in operation and that Snyder Bros. & Harson are the contractors for 17 miles additional. There is no lack of funds for completing the road. Ch. Engr., L. J. Kopke.

RED RIVER & SOUTHWESTERN.—W. A. Squiers, Secy., Henrietta, Tex., writes us that the bonds will soon be ready to sell for laying the rails on the 30 miles now ready from Henrietta, Tex., to Archer City, and that the road will be extended on to Albany, Aberline, San Angelo and Spofford Junction, on the Mexican International, a distance of 400 miles, as soon as men and money can do it. Pres., E. H. Ecort; Ch. Engr., T. W. Wathen.

TRINITY, CAMERON & WESTERN.—M. P. Kelley, Georgetown, Tex., writes us that subcontracts for building this railway will be let as soon as the railroad commission passes on the work already done. The route is from Granger, through Davilla, Cameron, Hearne, Wheelock and Madisonville to Trinity, 130 miles. The line has been surveyed, right of way obtained, depots located and necessary capital secured. M. P. Kelley & Co. have the contract for the complete construction. Ch. Engr., John O'Neil.——The Georgetown & Granger, which is to be an extension of this road, has been graded and is expected to be in operation by Feb. 15. This line is 15 miles in length.

Projects and Surveys.

BRAZOS & BURLESON.—Prof. J. C. Nagle, College Station, Tex., who made preliminary surveys for this railway last summer, writes us that the road is projected by farmers who are now busy with their crops and have had some difficulty in securing the necessary capital. The road would be 17½ miles in length extending from Clay Station.

FARMERVILLE.—This projected railway, 27 miles in length, was noted in our issue of Oct. 18. W. P. Chandler, Chm. Com., Farmerville, La., is now reported as soliciting bids for a survey of the route.

GALVESTON & GREAT NORTHERN.—A press report from Wichita, Kan., states that Capt. Edward Roemer, Ch. Engr., New York, and Matthew Hays and P. J. Dougherty, railway contractors, of New York, are at Wichita moving along the proposed line of the road, and submitting propositions to the various towns and counties through which it is desired to build. Captain Roemer has just returned from London, where he spent two months, and where he is said to have secured a promise of funds to construct the road. In an interview, he said work would begin at Galveston by Jan. 1, and soon thereafter at Denison, Tex., and that as soon as the question of aid had been determined operations would commence in Kansas, and be continued southward until the two sections meet. The proposed road is to run from Galveston to Niobrara, Neb., a distance of 1,000 miles, and will take in the extensive coal fields of the Indian Territory. Mr. Roemer was interested in several railway companies incorporated last spring to build north and south roads. The Gulf & Interstate, which is backed by the Populists and is projected from Galveston to North Dakota, commenced work on its road at Galveston Bay some time ago, as noted in these columns.

ST. LOUIS, AVOYELLES & SOUTHWESTERN.—Ira W. Sylvester, Ch. Engr., Alexandria, La., writes us that surveys, both preliminary and locating, have been made and the right of way secured for this railway, which is projected from Bunkie, La., on the Texas & Pacific, through Evergreen, Cottonport, Long Bridge, Mansura and Marksville, a distance of 42 miles. Avoyelles parish has voted a 5-mill tax for 10 years in aid of the road. Pres., F. M. Welch.

WACO, PALESTINE & ALEXANDRIA.—W. B. Johnson, of G. R. Cooke & Co., Mech. Engrs., Palestine, Tex., writes us that this company is being organized to build a railway from Waco, Tex., to Alexandria, La., passing through Mexia, Palestine, Nacogdoches and San Augustine. The road will be about 300 miles in length and it is confidently expected that the entire right of way will be donated and $200,000 to $300,000 in aid voted. The road can be built for about $9,000 per mile and the total cost complete is estimated at $5,000,000. Mr. Johnson is general manager of the prospective company.

ELECTRIC AND STREET RAILWAYS.

NORWAY, ME.—The Norway & Paris St. Ry. Co. has been formed to construct a line two miles in length. Work will probably begin in the spring. Directors, G. L. Beal, Norway; J. F. Hill, Augusta; H. L. Shepard, Rockport.

CONCORD, N. H.—The Concord St. Ry. Co. is reported as considering extending its electric line to East Concord.

NASHUA, N. H.—The Nashua St. Ry. Co. has petitioned for permission to equip its line with electricity.

CONWAY, MASS.—A correspondent writes us that tracklaying was completed on the Conway Electric St. Ry., 5¼ miles in length, Nov. 8, some ballasting remaining to be done. The power house is about half finished. Poles are up, but not yet connected, and work of strengthening bridges is yet unfinished. Daniel O'Connell & Son, Holyoke, were the contractors for grading and tracklaying.

NORTHAMPTON, MASS.—The Northampton St. Ry. Co. is reported as to extend its line next spring from this city to East Hampton, a distance of four miles.

PALMER, MASS.—The construction of an electric railway by the Central Massachusetts Electric Co., to connect this place with Monson, is being agitated.

WESTFIELD, MASS.—Press reports state that arrangements have been made by the Compressed Air Car Co. and the syndicate controlling the Woronoco St. Ry. Co., by which the railway is to be leased to the compressed air company. It is proposed to organize a company with a capital stock of $100,000 to manufacture the cars in Westfield and to operate and extend the street railway, using the line to test the cars before shipping them to other localities. The conditions of locating the plant in Westfield and accepting the proffered lease of the railway is that $50,000 of the $100,000 stock be raised in the town.

PROVIDENCE, R. I.—The Union R. R. Co. has petitioned for permission to extend its electric line.

MILFORD, CONN.—J. D. Brown is securing signatures to a petition for a charter for an electric railway between this town and Bridgeport. It is reported that the construction work will be begun in the spring if the charter is obtained.

BINGHAMTON, N. Y.—The Binghamton, Lestershire & Union R. R. Co has petitioned for right of way through Union. The trustees will consider the matter Nov. 26. J. P. E. Clark, Supt. Binghamton St. R. R. Co., is reported as saying that work will commence in the spring.

CORNING, N. Y.—Press reports state that the Citizens' Electric Street Ry. Co. has been reorganized with the following directors: J. A. Drake, F. D. Kingsbury, B. W. Wellington, John Magee and A. A. Houghton. It is the intention of this new board to push the street railway project in this city as rapidly as possible.

FLUSHING, N. Y.—The Flushing & College Point Electric R. R. Co. has petitioned for permission to extend its line from Sanford and Parsons Aves. to the Flushing cemetery.

GLENS FALLS, N. Y.—It is reported that the Otis Elevator Co., New York, is contemplating building a cable road to the top of Mount Ferguson.

MECHANICSVILLE, N. Y.—The trustees have granted a franchise to Powers Bros., Lansingburg, for an electric railway from this city to Stillwater.

NORTH TONAWANDA, N. Y.—J. J. MacIntire is securing right of way for the proposed electric railway on Grand Island.

RUTHERFORD, N. J.—D. E. Culver is to petition the council for a franchise for an electric railway. It is probable that George Forbush, who is president of another company, will also soon petition for a similar franchise.

HOMESTEAD, PA.—H. C. Johnson & Co., Pittsburg, have been awarded the contract for the electrical equipment of the Homestead St. Ry., five miles in length, and the Homestead & Highlands St. Ry., 5½ miles in length.

MECHANICSBURG, PA.—The Mechanicsburg & Boiling Springs Electric Ry. Co. has been incorporated to build a railway seven miles in length; capital stock, $100,000; Pres., J. B. Skyles, Martinsburg.

PHILADELPHIA, PA.—The Philadelphia & Lansdale Ry. Co. has been incorporated to construct an electric railway 16 miles long; capital stock, $100,000; Pres., Robt. A. Welsh.——Press reports state that the Chestnut Hill & Spring House Turnpike Co., Flourtown, has transferred the control of the road to the People's Traction Co., whose purpose is to construct on the turnpike from Chestnut Hill to Fort Washington. Pres., Daniel Williams; Secy., C. O. Kruger; Treas., Stephen Crothers. The omce of the company will be removed from Flourtown to Philadelphia.

PHILIPSBURG, PA.—Bids are asked until Dec. 4 for constructing boiler and engine house, etc., for the Clearfield Traction Co.; Engr., E. W. Hess.

PITTSBURG, PA.—The Second Ave. Traction Co. has been incorporated with a capital stock of $10,000, to build a double track railway to connect McKeesport, Dravosburg, Homestead and Coraopolis with this city; length, 53 miles; Treas., W. F. Ford, Pittsburg; G. T. Hamilton, Edgewood.——Press reports state that Brown & Bros., bankers, of New York, are at the head of a new traction railway syndicate that has taken hold of all the small trolley lines between Pittsburg, McKeesport, Homestead and Wilmerding. The syndicate has procured a charter.——The council is discussing the question of granting permission to the Central Passenger Ry. Co. to extend its line, and the Pittsburg & Arlington Ave. St. Ry. Co., newly incorporated, to build its proposed road.

CATLETTSBURG, KY.—The Ashland & Catlettsburg St. Ry. Co. has secured a franchise for an electric railway, the construction to be commenced within six months.

AKRON, O.—T. F. Walsh has been granted a franchise for a street railway from the end of his present line to the Portage county line. It is the intention to build to Kent.

CINCINNATI, O.—The Cincinnati St. Ry. Co. has petitioned the commissioners of Hamilton county for permission to extend its two electric lines. Address, W. L. Dickson.

GREENWOOD, IND.—Press reports state that Grafton Johnson and J. A. Polk, Greenwood, have applied to the Johnson county commissioners for a right of way for an electric line between Indianapolis and Franklin. A request was granted for Pleasant township, Johnson county, to vote on a proposition to appropriate $34,000 toward building an electric railway between Greenwood and Franklin.

ELYRIA, O.—Press reports state that a company has been formed here to construct an electric railway between this city and Oberlin. The capital stock is to be $100,000, and the road will be built next spring. The projectors include C. A. Metcalf and A. R. Webber, of this city; W. B. Thompson, Lorain; J. B. Thompson, Westview; W. B. Bedortha and Albert H. Johnson, Oberlin.

NEWBURG, O.—The trustees of Newburg township have granted a franchise to the Cuyahoga Suburban Ry. Co. to construct an electric railway to Randall. The contract for constructing the line has been awarded to A. W. Buel.

MACKINAC ISLAND, MICH.—Press reports state that a franchise has been granted by the council to a Grand Rapids company allowing it to build an electric railway around the Island, which, with a telephone and electric light system, will cost $125,000.

SAGINAW, MICH.—The City of Saginaw St. R. R. has been purchased by the Union St. Ry. Co. for $90,000 to $95,000. It is understood that the line will be equipped with electricity, and will probably be extended to Bay City. A power house to cost $50,000 is to be built.

SALINA, KAN.—Right of way and a cash bonus have been secured by L. M. Erb, Leavenworth, for the proposed electric railway. It is probable that the construction will be commenced as soon as the franchise is granted.

CARTHAGE, MO.—The Jasper County Electric R. R. Co. has been incorporated to build from this city to Joplin, a distance of 15 miles; capital stock, $150,000; directors, F. H. Fitch, J. W. Halliburton, S. M. Reynolds.

KANSAS CITY, MO.—The Metropolitan St. Ry. Co. has decided to petition for permission to equip its line with electricity.

ST. LOUIS, MO.—The Carthage, Webb Cy., Joplin & Galena Electric Ry. Co. has been incorporated to build a railway 17½ miles in length; capital stock, $175,000; incorporators, J. J. Taussig and D. R. Powell, St. Louis; C. C. Carroll, Springfield.——It is reported that efforts are being made to construct an electric railway to connect East St. Louis, Brooklyn, Venice and Madison, Ill.

INGERSOLL, ONT.—It is reported that the construction of an electric railway between this place and Port Burwell is being agitated.

HIGHWAYS.

MASSACHUSETTS.—The town of North Adams has voted to contract with the state to build one mile of road through Greylock, and will borrow $7,500 for this purpose. The expense of building the road is borne by the state and county, three-fourths by the former and one-fourth by the latter.

NEW JERSEY.—The contract for building the stone road from Paulsboro to Westville, a distance of 6¼

miles, has been awarded to Shanley Bros., at 74 cts. per sq. yd. The work must be completed by July 1, 1895, and the total cost will be $58,000, according to reports.

BRIDGES.

HARTFORD, CONN.—The Berlin Iron Bridge Co. has been awarded the contract for a bridge across the Connecticut between this city and East Hartford, at $274,900. The bridge will have five spans of 158 ft. 6 ins. each, one span of 105 ft., and a lift span of 35 ft., 30 ft. in the clear. The roadway will be 30 ft. wide between the trusses; sidewalks 10 ft. wide on the upstream side, and the electric railway support on the downstream side will be 12 ft. wide. The bids were as follows, (1) being for a steel and iron Pratt truss, (2) for camel-back, and (3) for parabolic construction:

	1.	2.	3.
Berlin Iron Bridge Co.	$274,900	$293,840	$301,500
Dean & Westbrook	280,900	298,300	308,200
R. P. Hawkins' Iron Wks.	284,200	296,100	305,700
Phoenix Bridge Co.	290,500	302,800	312,000
Boston Bridge Works	288,350	305,000	304,300

BUFFALO, N. Y.—The park commissioners have selected a site for a new bridge over the canal at the foot of Porter Ave. It is hoped to begin the construction within a few weeks; estimated cost, $25,000.

NEW YORK, N. Y.—The board of estimate has approved the plans for the bridge across the Harlem River from First to Willis Ave., at an estimated cost of $1,663,000, and has appropriated $30,000 to begin the work.

ROME, N. Y.—Bids are asked until Dec. 3 for the construction of a swing bridge over the Black River Canal on Garden St. K. S. Putnam, Cy. Chamberlain.

PHILADELPHIA, PA.—The Pennsylvania R. R. Co. is reported as to petition at the next meeting of the board of port wardens for permission to begin work on the proposed bridge across the Delaware River in the northern section of the city. The plans for the bridge have been approved by the government. The bridge will have three through spans, each 540 ft. long, and a draw span 330 ft. long.

SCRANTON, PA.—Bids are asked, according to reports, until Dec. 6 for constructing the superstructure of the Linden St. bridge over the Lackawanna River, and until Dec. 13 for the superstructure of the Spruce St. bridge over the Roaring Creek. M. T. Lavelle, Cy. Clk.

BALTIMORE, MD.—Bids are asked until Dec. 5 for building an iron draw span and two fixed iron spans across Bear Creek, Baltimore county. Wm. H. Shipley, Supt. Bridges, County Comrs., 219 East Fayette St.

CLEVELAND, O.—Efforts are being made by residents of the West Side to secure a high-level bridge from the foot of Willett St., over the railways and gulley to Rhodes Ave., at an estimated cost of $50,000.

TOLEDO, O.—L. P. Harris, Cy. Clk., has been directed to advertise for bids for a lift bridge over Swan Creek at Perry St., and preparations are being made for a new bridge across the Maumee River, for which $200,000 of bonds will be issued as soon as the committee on bridges determine where it will be located, and bids will then be advertised for the construction.

WARREN, O.—Bids are asked until Dec. 10 for the superstructure of a steel girder bridge across the Mahoning River. A. E. Andrews, Cy. Clk.

CHICAGO, ILL.—The bids received for constructing three swing bridges across the drainage canal were published in our issue of Nov. 8, under Contract Prices. The bids have all been rejected and the drainage board is reported as having decided to erect fixed bridges at these places.

CHIPPEWA FALLS, WIS.—The board of works has rejected the bids for a steel bridge at the Star Mills and will advertise for new bids, according to reports.

MONTREAL, QUE.—Bids are asked until Dec. 5 (postponement of date from Nov. 21) for the steel superstructure and trestle bents for a bridge over the Canadian Pacific Ry. tracks on Notre Dame St. Percival W. St. George, Cy. Surv.

EDMONTON, N. W. TER.—The government is reported about to commence the construction of a $60,000 bridge at this place.

WATER-WORKS.

MANCHESTER, VT.—The Manchester Water Co. has filed articles of incorporation; capital stock, $50,000; incorporators, H. W. Miller, John Marsden, M. S. Colburn and others. The works are about completed.

MORRISVILLE, VT.—Work has been stopped on the new works until next spring, when the remaining pipe will be laid and a reservoir built.

MONSON, MASS.—Bids were asked until Nov. 21 for the purchase of $50,000 of 4% water bonds. A. D. Norcross and E. F. Morris, Comrs.

NEW BEDFORD, MASS.—Bids are asked until Dec. 7 for the purchase of $100,000 or $200,000 of 4% bonds, being a part of the $1,300,000 authorized for improving the water supply.

WINCHENDON, MASS.—Geo. M. Whitney writes us that the committee has not concluded its investigation as to a supply and no action has yet been taken by the town in regard to adopting plans.

JEWETT CITY, CONN.—The committee is negotiating with Hartford parties to put in works, according to reports. G. H. Jennings is a member.

FORT PLAIN, N. Y.—The citizens have voted, 362 to 36, to appropriate $55,000 for new works.

JOHNSTOWN, N. Y.—J. J. Buchanan, Supt., writes us that the following bids were received Nov. 19 for the extensions noted in our issue of Nov. 1, the work including 30,400 ft. of 16-in. cast iron conduit:

Bartle & Coon, Scranton, Pa.	$61,898
Troy Public Works, Troy, N. Y.	73,763
P. H. Harrison & Son, Newark, N. J.	64,696
Beckwith & Quackenbush, Herkimer, N. Y.	67,485
G. D. Grannis, Syracuse, N. Y.	69,553
S. C. Ferguson, Gloversville, N. Y.	73,707
Hendricks, Taylor & Warren, Nonotuck, Mass	80,333
Pidgeon Bros., Albany, N. Y.	67,511
M. E. Birdsey, Fayetteville, N. Y.	63,839
John Marsden, Utica, N. Y.	58,381
Smith Bros., Pelhamville, N. Y.	64,025
Seymour & Banker, Gloversville, N. Y.	63,552

MORRIS, N. Y.—Bids are asked until Dec. 13 for constructing the works noted last week, as stated in our advertising columns. Engrs., Potter & Folwell. Gilbert Carpenter, Pres. Comrs.

NYACK, N. Y.—The Nyack Water Works Co. is reported as negotiating with the New York Filter Co. for a $20,000 filter plant.

CLAYTON, N. J.—The Clayton Water Co. has been incorporated; capital stock, $75,000; incorporators, Edwin F. Partridge, H. Bayard Hodge, J. S. Keen, Jr., Philadelphia; J. M. Moore, M. F. Dubois, Clayton, and others.

EGG HARBOR CITY, N. J.—It is reported probable that works and an electric light plant will soon be put in.

GLASSBORO, N. J.—The Glassboro Water Co. has been incorporated; capital stock, $75,000; incorporators (same as Clayton Water Co.), Isaac Moffett, S. D. Beckett, Glassboro, and others.

POINT PLEASANT, N. J.—The Point Pleasant Water-Works Co., noted last week as incorporated, has petitioned for a franchise.

BEAVER FALLS, PA.—Contracts for constructing new works were recently awarded, as noted in these columns, but owing to a technicality an injunction was secured. The council has passed an ordinance setting Dec. 22 as a day for a new election to vote on an issue of $123,000 in bonds for the work, and it is reported that the vote will be almost unanimous.

CASHTOWN, PA.—The Cashtown Water Co. was incorporated Nov. 15 with a capital stock of $2,000; Treas., Emma J. Swartz.

CANONSBURG, PA.—The Canonsburg Water Co. has been incorporated, with a capital stock of $2,000, by Wm. H. Warwick; Robt. A. Johnson, John E. Hall, Pittsburg.

COLUMBIA, PA.—C. W. Stevenson, Clk., writes us that nothing definite has been decided as to the proposed works. The ordinance is now before the councils. Address Col. J. W. Bratton.—The Conewago Water & Power Co. has been incorporated to put in works; capital stock, $20,000; Treas., Walter H. Boyer, 1215 Filbert St., Philadelphia.

DUBOIS, PA.—The Falls Creek Water Co. is reported as negotiating to supply this place, three miles from Fall Creek.

DUQUESNE, PA.—The Crystal Water Co. is being organized by E. B. Fogle, D. I. Starr, Jr., W. N. Taylor and others.

FALLS CREEK, PA.—The Falls Creek Water Co. has been incorporated with a capital stock of $5,000; Pres., A. C. Hopkins; Treas., Geo. Weymouth, both of Lock Haven. The reservoir has already been constructed.

GALETON, PA.—A. W. Clinton, Secy. Pike Mills Water Co., incorporated this month, writes us that the works are completed.

GREENCASTLE, PA.—The works have been tested and accepted. Harry Birkinbine, Philadelphia, was the contractor.

LEBANON, PA.—Geo. W. Hayes, Cy. Engr., writes us that the ordinance for a new supply from Swatara Creek has been defeated in select council and that the whole subject of the much-needed additional supply is consequently still in a preliminary stage.

MEADVILLE, PA.—W. A. Doane, Cy. Engr., has been directed to prepare plans and estimates for the new works, and it is reported probable that bids will soon be asked for the construction.

RANKIN, PA.—The council has signed a 10-year contract with the Pennsylvania Water Co. for a supply, according to reports.

WILKES BARRE, PA.—The Wilkes Barre Water Co. has contracted with the Morison-Jewell Filtration Co., New York, for a 6,000,000-gallon filter plant.

APALACHICOLA, FLA.—Hebert & Laperg, Chattanooga, Tenn., have been engaged to make plans and specifications for the proposed works. We are informed that a direct pumping system will probably be adopted in view of the high winds prevailing on the coast and as there is no site for a reservoir.

BESSEMER, ALA.—The council has purchased the works of the Bessemer Land & Improvement Co., for $125,000, according to press reports.

MARION, ALA.—The contract for works has been awarded to J. C. Lee & Co., at $23,000.

MOBILE, ALA.—The special committee appointed last June has reported an act which the legislature will be asked to pass authorizing the city to issue $400,000 in 4 to 6% 30-year bonds for works.

CARROLLTON, KY.—A correspondent writes us that G. W. Pearsall, Harriman, Tenn., is preparing plans and specifications for works. The council has voted to issue $20,000 in bonds for the plant and the contracts will be awarded so that the construction can be commenced before Jan. 1, if possible.

CATLETTSBURG, KY.—The Catlettsburg Water-Works Co. is negotiating with Kenova and Credo, W. Va., to supply those towns, and has about closed a contract with Credo, according to reports. Companies were incorporated some time ago to put in works at these places.

HOPKINSVILLE, KY.—Efforts are being made to have works put in by local parties.

LEXINGTON, KY.—Contracts for the proposed filter plant have been awarded as follows: Filter, O. H. Jewell Filter Co., Chicago; pumping machinery, Laidlaw-Dunn-Gordon Co., Cincinnati; stone work, Wm. Sleath, Lexington; slating, Ed. Bitterman; brickwork, Henry Tandy and Andy Bird; brick and cement, Pafft & Hulett; woodwork, Geo. Clark.

MADISONVILLE, KY.—C. O. Osburn, Cy. Clk., writes us that the question of works is being agitated, but that nothing definite will probably be done before spring. The only bonded indebtedness of the city is $1,900, which will be paid in the spring; population, 3,000.

ARLINGTON HEIGHTS, O.—Bids are asked until Nov. 24 for constructing works, which J. T. Hall, Clk., writes us will include 6,200 ft. of 4-in. cast iron pipe, 1,850 ft. of 6-in., 20 double seat stop valves, 20 extension valve boxes, 13 double nozzle fire hydrants, 2 meters, etc. Engr., H. C. Innes, Hartwell, O.

ATTICA, O.—L. L. Sutton, Clk. Trustees, writes us that the following contracts were awarded at the opening of bids Nov. 13, the bids for machinery being rejected: Pipe, Ohio Pipe Co., Columbus, $3,417; brick tower, Engelhart & Fink, Attica, $1,522; steel tank, Variety Iron Works, Cleveland, $1,077; hydrants, valves, etc., and laying pipe, $2,568. The other bidders were as follows: Dean Steam Pump Co., Chicago; Taft & Dole, Columbus, O.; Dellinger & Jackson, Attica, O.; Phillips & Bixel, Cleveland, O.; W. H. Snyder, Carey, O.; Chandley Bros. & Co., Beaver Falls, Pa.; Louis Mayer, Lancaster, O.; Anniston Pipe & Foundry Co., Anniston, Ala.; Addyston Pipe & Steel Co., Cincinnati, O.; J. B. Clow & Son, Chicago; Ludlow Valve Co., Troy, N. Y.; Bourbon Copper & Brass Works, Detroit, Mich.; Rensselaer Mfg. Co., Chicago; Chapman Valve Co., Indian Orchard, Mass.

CADIZ, O.—Bids are asked until Dec. 3 for the purchase of water bonds, according to reports. Bids were asked in the summer for $35,000 of bonds for constructing works. W. H. Lucas is town clerk.

CLEVELAND, O.—Bids are asked until Dec. 14 for building 450 ft. of 8-ft. tunnel in clear, lined with 12½ ins. brick masonry; bottom to be 55 ft. below city base of levels; work including two shafts, 9 ft. in diameter at top and 9½ ft. at bottom. J. H. Farley, Dir. Pub. Wks.

COLUMBIANA, O.—Bids are being received for sinking test wells, according to reports. E. L. Roninger, Cy. Clk.

LEBANON, O.—R. B. Corwin, Clk., writes us that an election will be held Jan. 8 to vote on an issue of $50,000 in bonds for works; population, 3,100.

PORT CLINTON, O.—Bids are asked until Nov. 23 for the purchase of $35,000 in bonds, which were voted last month for works. J. H. Faus, Village Clk.

RAVENNA, O.—The trustees have recommended that more wells be drilled and $3,850 spent in adding to the water supply.

BRIGHTWOOD, IND.—Bids are asked until Nov. 28 for sinking test wells 105 ft. deep for a supply for the proposed new works. Wm. Wright, Secy. Com.

MONTPELIER, IND.—The citizens have voted by a majority of 81 for works.

CENTERVILLE, MICH.—An election will be held Dec. 4 to vote on an issue of $10,000 in bonds for works. E. L. Clapp, Clk.

DECATUR, MICH.—Frank C. Stapleton, Village Clk., writes us that at an election Nov. 15 the village voted, 234 to 94, to issue $12,000 in bonds for works.

CASEY, ILL.—The council is reported to have purchased 40 acres of land as a site for a reservoir, preparatory to putting in works.

OSWEGO, ILL.—Bids are asked until Dec. 5 for constructing works (postponement of date from Nov. 5). Engr., Jason F. Richardson, Jr., Ottawa. G. H. Voss, Cy. Clk.

QUINCY, ILL.—A press report states that the council is again discussing a proposition for building new works.

ROSSVILLE, ILL.—S. W. McGuire, Village Clk., writes us that the contract for works has been awarded L. W. Straw & Son, Danville, Ill., at $4,709. Hover & Warner, Rossville, bid $5,300; S. L. Whistler, Joliet, $6,000; Carson & Co., Danville, $4,960, and the Dayton Steam Boiler Co., Dayton, O., $2,095 for the stand-pipe only.

TURNER, ILL.—The proposition to issue $10,000 in bonds for works was defeated Nov. 13 by 33 votes.

VIRGINIA, ILL.—A committee is securing a list of those who will take water if works are put in.

CHIPPEWA FALLS, WIS.—The council is considering the purchasing of the works.

CLINTON, WIS.—The council has voted to issue $13,000 in bonds for works, according to reports.

MAUSTON, WIS.—Geo. S. Grubb writes us that nothing definite is likely to be done for works for some time.

SPARTA, WIS.—The citizens have voted, 435 to 179, in favor of works.

WAUPUN, WIS.—R. H. Owen, Cy. Clk., writes us that at the election Nov. 13 the citizens voted by 96 majority to issue $33,000 in bonds for work and that an engineer is now preparing the plans and specifications.

IOWA FALLS, IA.—It is reported probable that the mains will soon be extended to East Iowa Falls.

PELLA, IA.—John Faassen, Cy. Clk., writes us that the citizens voted on Nov. 8 to put in works (estimated to cost about $30,000), but that no supply has been decided upon or plans prepared and the construction will probably be postponed until after the March election; population, 3,000.

SIOUX CITY, IA.—The council has granted a franchise for the construction of the Morning Side works.

LONG PRAIRIE, MINN.—The city is reported to have sold $10,000 in 20-year 6% water bonds at 5% premium.

MONTEVIDEO, MINN.—Bids are asked until Dec. 10 for the purchase of $6,110 in 6% water bonds. C. A. Fosnes, Village Pres.

RUSHFORD, MINN.—Bids are asked until Dec. 8 for the purchase of $4,000 in 5% water bonds. F. A. Olson, Cy. Clk.

SENECA, KAN.—F. L. Burrell, Fremont, Neb., has made plans for works, and at an election Nov. 15 the citizens voted almost unanimously to issue $30,000 in bonds for the construction.

TALMAGE, NEB.—The contract for works has been award to Horrum & Ritter, Talmage, at $7,791, according to reports, the other bidders being Miller & Egan, Nebraska City, $7,981, and Van Debergh & Norton, $8,000.

WEST PLAINS, MO.—J. A. Truex writes us that this place is not likely to have any works for some time.

CAMERON, TEX.—C. W. Lawrence, Secy., writes us that the following bids were received for a complete plant, including a 12-ft. stand-pipe:

Albert Wirz, Dallas	$21,450
W. E. De Long, Waxahachie	20,950
O. G. Gorman, Dallas	19,900
Brown & Dabney, Dallas	25,000
Geo. McIntosh, Bloomington, Ill.	24,900
Jaeger & Blanchard, Rich Hill, Mo.	20,450

The contract was awarded to Jaeger & Blanchard

at $21,802 for complete plant, with a 16-ft. standpipe.

DALLAS, TEX.—The council has voted to have specifications made for a 30-in. cast iron pipe line from Record Mill crossing to the Turtle Creek pumping station.

FORT WORTH, TEX.—Jno. G. Montzemy, Cy. Secy., writes us that there is talk of constructing reservoir and dams, etc., estimated to cost $131,000, as stated in our issue of Nov. 1, and that bids will probably be received within 30 days for the three $5,000 dams noted Nov. 8. Cy. Engr., T. E. Cappage.

FLORENCE, COLO.—The Florence Power & Water Co. was incorported Nov. 13 with a capital stock of $100,000, by W. E. Johnson, W. K. Johnson and H. A. Sumner.

PUEBLO, COLO.—The proposition to issue $75,000 in north side water bonds was carried by 48 majority.

ASTORIA, ORE.—Bids will soon be asked, according to reports, for new works to cost about $200,000, as described in our issue of Oct. 25. Engrs., Adams & Gemmell, Salt Lake City, Utah, and Pendleton, Ore. H. G. Van Dusen is clerk of the commissioners.

DAYTON, ORE.—A preliminary ordinance has been passed for works and electric lights.

McMINNVILLE, ORE.—A company has been organized to put in works and an electric light plant; water supply from the hills two miles distant. It is reported that a franchise has been granted.

CARSON, NEV.—The Carson Water Co. is reported as commencing work on a 1,000,000-gallon storage reservoir.

LOS ANGELES, CAL.—The Clear Spring Land & Water Co. has been incorporated; capital stock, $100,000; incorporators, Ralph Rogers, Garvanza; Sherman Smith, A. W. Berry, Jas. Booth and J. H. Blanchard, Los Angeles.

AYLMER, ONT.—The Ottawa "Journal" states that E. J. Rainboth proposes to commence building the works this fall.

CHATHAM, ONT.—John Tissiman, Town Clk., writes us that the present supply is from wells which are giving out and the only available source is Lake Erie, 16 miles distant. The water company is not inclined to incur the expense of an additional supply and has negotiated with the council to sell the plant (for $132,000). The question will be voted upon by the citizens Dec. 5 and if carried the purchase will be completed and steps will then be taken to borrow an additional sum of $100,000 for extensions, but it is not probable that the work can be commenced before early next summer.

WINDSOR, ONT.—The water board is reported as communicating with several filter companies as to the cost of a filter plant.

IRRIGATION.

JULESBURG, COLO.—Several hundred men with teams and scrapers are reported at work on an irrigation ditch which begins eight miles from this place and is to extend through Perkins county for a distance of 65 miles. It will be 24 ft. wide at the head gate and forseveral miles beyond, and will carry 6 to 10 ft. of water. No flumes are to be built. Bonds for $90,000 voted by Perkins county have been sold.

NEW COMPANIES.—Irrigation Land & Power Co., Stockton, Kan.; $100,000; I. N. Pepper, T. E. Baldwin, A. E. Wilson.

Six Mile Ditch & Reservoir Co., Boulder county, Colo.; $20,000.

Ingalls Irrigation & Canal Co., Ingalls, Kan.; $50,000; D. W. Balton, D. B. Hungate, W. M. Brooks.

American Falls Land Irrigation & Power Co., Monroe, Wis.; $200,000; Nicolaus Schmidt, John Legler, H. H. Hefty.

Gothenburg SSouth Side Irrigation Co., Gothenburg, Neb.; $40,000; H. S. Williams, S. C. Lloyd, E. B. Quackenbush.

SEWERS.

BROOKTON, MASS.—The aldermen have voted to petition for authority to issue $250,000 in bonds to build about 18 miles of the system next summer.

PROVIDENCE, R. I.—The department of public works is making arrangements for the construction of the East Side sewer under the river.

ROCKVILLE, CONN.—The construction of a system is being agitated and it is reported probable that the matter will be considered by the council next year.

BUFFALO, N. Y.—The board of public works has been directed to prepare plans and advertise for bids for an 18-in. iron and 18, 12 and 10-in. tile sewer in Dyer St. from the Buffalo River to a point 500 ft. south of the Abbott Road.

NEW BRIGHTON, N. Y.—The trustees have received the following bids for reconstructing a sewer on Bement Ave.: P. Hart & Sons (awarded contract), $3,950; W. J. Dowling, $4,664, and Joseph Johnson, $4,130.

NIAGARA FALLS, N. Y.—The city engineer estimates that the sewers petitioned for by the Niagara Falls Power Co., as noted last week, would cost $25,800. The council is considering the question of construction.

ROCHESTER, N. Y.—Bids are asked by the east side trunk sewer commission until Dec. 1 for constructing an outlet sewer through Wards 4, 7 and 12.

WHITESTONE, N. Y.—Plans for a system are being prepared by G. A. Roullier, Cy. Engr., Flushing.

JERSEY CITY, N. J.—It is stated that the Hudson county grand jury has completed its investigation of the Jersey City water question and is preparing a report which will recommend that a sewer be built to carry the sewage of Paterson and Passaic past the Jersey City intake at Belleville. This can be done at a cost of $500,000, it is said, and will do away with the need for finding a new source of supply.—The following bids have been received for constructing a 24-in. brick sewer in St. Paul Ave.: Sheridan & Shea Co., $5,332; P. J. Mullery, $4,634; John Hopkins, $4,541; Thomas Wood, $4,538; Wm. Ormsby, $3,285. G. T. Bouton, Clk

NEWARK, N. J.—Bids are asked until Nov. 30 for constructing 1,200 ft. of 15 and 12-in. pipe sewers in Littleton Ave. J. C. Mundy, Gen. Supt. Pub. Wks.

WEST HOBOKEN, N. J.—The following bids have been received for constructing sewers in Demott St.: Callery & Murphy, $2,800; Edward O'Neil, $3,000; H. M. Schneider, $2,710; Patrick Flaherty, Jr., $3,450; John Hopkins, $2,240.

FORTRESS MONROE, VA.—It is reported that as soon as assessments have been collected for the new sewerage system that bids will be advertised for, so that work will be commenced by Jan. 1. Maj. Davis, of the U. S. Engineer Corps, has charge of the work.

ASHTABULA, O.—Bids are asked until Dec. 3 for constructing sewers in five streets. A. B. Phillips, Clk.

COLUMBUS, O.—H. C. Caimon has been awarded a contract for constructing sewers in district No. 1 at $7,987.

TOLEDO, O.—L. P. Harris, Cy. Clk., writes us that 16,184 ft. of sewers have been constructed in 20 streets during the season.

INDIANAPOLIS, IND.—The following bids have been received for constructing a main sewer, 4,810 ft. in length, in Pine, John and Bellefontaine Sts.: D. De Ruiter, $6.73 per lin. ft.; J. W. Wilding & Co., $6.24; Bossert & Waterman (awarded contract), $5.80; South Bend Construction & Improvement Co., $8.31; Daniel Foley, $7.25; W. C. Allen & Co., $6.33; W. R. Mercer & Son, $6.57; Fulmer, Seibert & Co., $6.25.

EAST ST. LOUIS, ILL.—Bids are asked until Nov. 22 for constructing 14,878 ft. of 30 to 6-in. pipe sewers, with 6,732 cu. yds. of excavation. A. E. Abend, Cy. Engr.; J. J. Kane, Cy. Clk.

ST. PAUL, MINN.—Bids are asked until Nov. 26 for constructing a sewer in Roble St.; J. C. Mueller, Clk. Bd. Pub. Wks.

MEXICO, MO.—It is reported that the council is in favor of issuing $100,000 in bonds for a system.

ST. LOUIS, MO.—The board of public improvements has adopted ordinances appropriating $14,500 for constructing a sewer in Clarendon Ave., and has voted to construct a sewer in Gasconade St., at an estimated cost of $3,600.

ST. JOSEPH, MO.—Contracts have been awarded as follows for constructing sewers: District 37, Daniel Donahue; district 56, W. E. Gibson; districts 25 and 43, John Maxwell.

SAN ANTONIO, TEX.—Bids are asked until Dec. 20 for furnishing materials and for constructing six miles of 52 to 26-in. brick, and 68 miles of 24 to 8-in. pipe sewers, including 843 manholes and 210 flush tanks, as stated in our advertising columns. E. R. Morton, Cy. Clk.; A. C. Pancoast, Cy. Engr.; Consult. Engr., S. M. Gray, Providence, R. I.

DENVER, COLO.—A resolution has been adopted by the council for the construction of a sewer in 13th St.

SEATTLE, WASH.—The council has passed an ordinance appropriating $55,000 for constructing a 30 × 20-in. brick sewer in 12th St. R. F. Stewart, Cy. Clk.

——The aldermen have passed an ordinance for the construction of a sewer in 12th St. estimated to cost $4,800.

GUELPH, ONT.—James Hutchson, Cy. Engr., writes us that he is making preliminary surveys and a topographical map of the city, but that nothing else has been done towards securing plans or estimates for a system.

NIAGARA FALLS, ONT.—The council will submit a bylaw for constructing sewers estimated to cost $88,000 to be voted on by the citizens Dec. 3.

TORONTO, ONT.—Bids are asked until Nov. 24 for supplying the following materials for one year: Lumber, pit gravel, sand, cedar paving posts, hardware, wire nails, sewer pipe, horse feed, castings, etc. Daniel Lamb, Chn. Com. on Wks.

STREETS.

NEW HAVEN, CONN.—The street committee has recommended that $500,000 in bonds be issued for paving portions of 27 streets; granite blocks to be used on business streets and asphalt, asphalt blocks and brick on the residence streets.

BUFFALO, N. Y.—The committee has recommended that the following contracts be awarded: Barber Asphalt Paving Co., Skillen St., $23,179; Essex Ave., $31,420; Inwood Place, $10,486; Carmine Place, $6,482; German Rock Asphalt Paving Co., Kehr St., $25,599; Delaware Ave., $53,200; Goemble Ave., $11,522.

NEW YORK, N. Y.—Bids are asked until Dec. 4 for grading portions of six streets and for curbing and flagging sidewalks of the same streets. M. T. Daly, Comr. Pub. Wks.

READING, PA.—The council is considering a bill providing for the holding of a special election to vote on an issue of $900,000 in bonds, $200,000 for underground drainage, $50,000 for the erection of bridges, $50,000 for house sewage mains in the first and third districts, and $600,000 for street paving.

WASHINGTON, D. C.—The commissioners have adopted resolutions for paving portions of seven streets with vitrified blocks, estimated to cost $13,100, and four streets with asphalt blocks, estimated to cost $9,400.

JACKSONVILLE, FLA.—Bids are asked until Nov. 26 for furnishing 30,000 sq. yds. of brick. L. H. Mattair, Cy. Engr.

OWENSBORO, KY.—J. E. Dawson, Cy. Engr., writes us that a proposition to borrow $135,000 for building brick streets was submitted to the voters Nov. 6 and carried. Work will probably begin in the early spring.

CLEVELAND, O.—The park commission has received 31 bids for constructing a driveway, in two sections, along the Doan Brook gully from St. Clair St. to Wade Park Ave. W. J. Garone was the lowest bidder for the whole driveway at $53,200 and Edward Cowley and A. E. French were the lowest for the two sections separately.

MASSILLON, O.—Bids are asked until Dec. 1 for paving Diamond Alley with brick. E. B. Bayliss, Cy. Clk.

SANDUSKY, O.—Bids are asked until Nov. 28 for 20,000 sq. yds. of brick paving. A. W. Miller, Cy. Clk.

TOLEDO, O.—Thomas McKinney has been awarded a contract for paving St. Clair St. with Medina stone blocks at $12,956.——L. P. Harris, Cy. Clk., writes us that during the past summer the city has awarded contracts for paving portions of 7 streets, 5 with firebrick and 1 each with Hallwood blocks and asphalt.

CHICAGO, ILL.—Press reports state that J. W. Utesch and G. W. Shepherd, of the sub-committee appointed by the judiciary committee of the council to investigate the merits of clay and fire clay brick for paving purposes, J. A. Moody, Deputy Comr. Pub. Wks., and J. H. Flagg, Ch. Engr. St. Dept., are visiting St. Louis and Cincinnati and other cities to examine brick pavements.

EAST ST. LOUIS, MO.—Bids are asked until Nov. 22 for 29,000 sq. yds. of brick or block paving, 53,300 cu. yds. of filling and 13,500 lin. ft. of curbing. J. J. Kane, Cy. Clk., writes us that the work is estimated to cost $100,000. A. E. Abend, Cy. Engr.

SOUTH OMAHA, NEB.—The council has passed an ordinance for paving three blocks of N St. with brick.

HOUSTON, TEX.—G. M. La Noue, Cy. Engr., has completed plans and specifications for paving four streets with either brick, macadam or asphalt. The city engineer is in favor of the latter.

ELECTRIC LIGHT AND POWER.

WEEDSPORT, N. Y.—The trustees have granted a franchise to the Weedsport Spring Wire Trust Co. to put in an electric light plant.

CAPE MAY, N. J.—A committee has been appointed by the council to investigate the cost of an electric light plant.

EGG HARBOR CITY, N. J.—There is talk of putting in an electric light plant.

McKEE'S ROCKS, PA.—The Phoenix Electric Co. has been awarded a contract for 30 arc lights of 2,000 c. p. each at $60 per light per year. The same company is to light Sheridan and Espien.

BALTIMORE, MD.—J. H. Harlow, Pittsburg, has been engaged to make surveys for transmitting electricity from Conowingo to this city. The feasibility of a large water-power plant on the Susquehanna River at Conowingo and the transmitting of electricity to this city have been discussed for some time. The necessary land and water front have been secured and a rough estimate obtained of the probable cost of the plant.

ATLANTA, GA.—Bids are asked by the General Electric Co. for 1,100 30-ft. and 400 45-ft. cypress electric light poles of not less than 6 ins. in diameter, poles to be delivered f. o. b. cars at Jacksonville, Fla.

LUDLOW, KY.—Efforts are being made to secure electric lights, according to reports.

OWENSBORO, KY.—J. E. Dawson, Cy. Engr., writes us that the council has appointed a committee, with W. P. Small as chairman, to receive propositions for an electric light plant to be completed next year.

BRADNER, O.—It is reported that the subject of electric lighting is being agitated.

CHAGRIN FALLS, O.—It is stated that this place is to have electric lights.

CLEVELAND, O.—Bids are asked until Dec. 12 for 251 electric lights and 4,377 oil lamps for one year. J. H. Farley, Dir. Pub. Wks.

BREMEN, IND.—G. F. Wahl writes us that an electric light plant will be put in next spring, but that contracts will not be awarded before March.

ELWOOD, IND.—One of the boilers at the electric light station exploded Nov. 15, destroying the building, according to reports.

TERRE HAUTE, IND.—R. B. Harrison, Pres. Terre Haute St. Ry. Co., has been awarded a contract for lighting the streets by electricity for five years at $63.95 per year per light. It is reported that the old company bid $90 and that it has retaliated by petitioning for an electric railway franchise.

DETROIT, MICH.—The committee has recommended that the eight bids received for about 40 high-pressure steam valves for the new electric light station be rejected and that new bids be called for. The prices ranged from $10 to $53.

GREENVILLE, ILL.—A. B. Cotton, Chicago, has been granted a franchise for an electric light plant, the city to pay $1,000 per year for street lighting.

SPRINGFIELD, ILL.—Press reports state that the Citizens Electric Co., which was organized to build a municipal electric lighting plant for this city, has awarded the following contracts: Standard Electric Co., Chicago, $37,970, for electrical apparatus, pole, line and construction; Buckeye Engine Co., $6,800, for three 160-HP. engines and one 120-HP. engine; and the Springfield Boiler Co., $8,180, for boilers, foundations, smokestacks, steam pipes and water connections.

APPLETON, WIS.—The Citizens' Electric Light & Power Co.'s plant will contain the following: a brick power house, 40 × 60 ft., and a brick boiler house, 40 × 40 ft.; a 150-HP. compound condensing engine, and a 1,000-light dynamo. Pres., M. H. Croswell; Secy and Treas., D. H. Pierce; Supt., John Peterson.

LEADVILLE, COLO.—It is reported that William Hanks, Vermont; W. W. Mason, Portland, Me., and Mr. Priddy, Pres., Leadville Water Co., are making arrangements to put in an electric plant, estimated to cost from $150,000 to $175,000, for the purpose of furnishing electric power for the mines. A 36-in. pipe line running from the Arkansas River at Bird's Eye to the mines, a distance of 12 miles, is to be constructed.

CAMERON, TEX.—The Cameron Water & Light Co. will put in an electric plant in the spring. C. W. Lawrence, Secy.

TACOMA, WASH.—The Tacoma Traction Co. has been incorporated with a capital stock of $500,000; incorporators, Stuart Rice, C. S. Fogg and G. B. Blanchard.

ANAHEIM, CAL.—Bids are asked until Nov. 27 for the construction of an electric light plant. M. Nebelung, Cy. Clk.

WINNIPEG, MAN.—It is reported that the Northwest Electric Light Co. will double the capacity of its plant next year, spending about $40,000.

NEW COMPANIES.—Dearborn Electric Co., Chicago, Ill.; $25,000; T. C. Rafferty, Charles Messer.

Citizens' Electric Light & Power Co., Terre Haute, Ind.; $50,000.

Muncie Electrical Works, Muncie, Ind.; $25,000; W. S. Richey, A. S. Richey, R. F. Platt.

People's Electric Co., Valparaiso, Ind.; $30,000; G. M. Nillis, O. E. Turner, J. S. Cummins.

Mound City Electric Light & Power Co., Mound City, Ill.; $5,000; A. J. Dougherty, E. G. Bruckman.

Madison Electric Light & Power Co., Madison, Neb.; $10,000; W. V. Allen, F. T. Prince, H. E. Becker.

GARBAGE DISPOSAL.

ASBURY PARK, N. J.—Information is wanted regarding garbage crematories, as stated in our advertising columns. Parker N. Black, C. E.

CAMDEN, N. J.—At a meeting of the streets committee Nov. 14 Julius Coty, of the Atlantic City board of health, spoke of the crematory in use in that city. The committee is expected to make a report at the next meeting of the council. B. H. Slivers, Clk. Com.

PHILADELPHIA, PA.—Specifications have been prepared and bids will be received within a few days, according to reports, for the removal of garbage and dead animals during the ensuing year. Bids must be upon blanks furnished by bureau of street cleaning and must state gross sum for the work, as well as separate sums for each district. J. H. Windrim, Dir. Pub. Wks.

READING, PA.—The board of health is reported as taking steps to secure an incinerating plant for the disposal of the garbage of the city.

WILKES BARRE, PA.—The city continues to discuss the question of a garbage crematory.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

PIER WORK.—Duluth, Minn.—Bids are asked until Dec. 10 for repair of pier at Superior, Wis. Maj. Clinton B. Sears, U. S. Engr. Office.

ENGINE HOUSES.—St. Louis, Mo.—Bids are asked by the board of public improvements until Dec. 4 for the construction of three new engine houses.

DIKE.—Philadelphia, Pa.—Bids are asked until Dec. 13 for constructing pile dike at mouth of Schuylkill River. Maj. C. W. Raymond, U. S. Engr. Office.

STONE.—Nashville, Tenn.—Bids are asked until Dec. 5 for supplying stone for building lock No. 5, Cumberland River. Capt. John Biddle, U. S. Engr. Office.

SCHOOL BUILDING.—Buffalo, N. Y.—The board of public works has selected a site for a $100,000 high school building, for which plans will soon be prepared.

SURVEYING.—Flemington, N. J.—Bids are asked until Dec. 15 for surveying about five miles of streets, as stated in our advertising columns. S. M. Cooley, Village Clk.

DOCK WORK.—New York, N. Y.—Bids are asked by the department of docks until Nov. 28 for repairing pier and dumping board at the foot of West 19th St., North River.

REMOVAL OF WRECK.—Wilmington, Del.—Bids are asked until Dec. 10 for removal of wreck of schooner "Mint," now lying in Leipsic River, Del. Wm. F. Smith, U. S. Agt.

ISLAND PROTECTION.—Richmond, Va.—Bids are asked until Dec. 11 for protecting Jamestown Island, as stated in our advertising columns. Col. Wm. P. Craighill, U. S. Engr. Office.

STREET CLEANING.—Cleveland, O.—Bids are asked until Dec. 12 for cleaning the paved streets and alleys of the city, the work being divided into three districts. J. H. Farley, Dir. Pub. Wks.

ELEVATORS, ETC.—Denver, Colo.—Bids are asked by the board of capitol managers until Nov. 28 for elevators, pumps and pressure tanks for the state capitol building. Herman Luelers, Secy.

TELEPHONE SYSTEM.—Washington, D. C.—Bids are asked until Dec. 18 for the construction of a telephone exchange system for the department of the interior. Wm. H. Sims, Acting Secy.

GATES.—Brooklyn, N. Y.—Bids are asked until Dec. 7 for safety gates at the bridge across Wallabout Canal at Washington Ave., as stated in our advertising columns. H. T. White, Comr. Cy. Wks.

DITCH WORK.—Wheatfield, N. Y.—Bids are asked until Nov. 28 for repairing the ditches for draining the low lands of this town, for which the last legislature appropriated $8,000. Address Chauncey Wichterman, Supt., Shawnee, Niagara county, N. Y.

CANAL.—West Duluth, Minn.—Chas. Craig, Henry and Wm. Clyne, and other surveyors left for Thomson last week to survey a canal route from Thomson to Fond du Lac, according to reports. The St. Louis Water Power Co. is said to be interested.

STATIONS.—Waterbury, Conn.—The railroad commissioners have accepted plans submitted by the New York & New England and the New York, New Haven & Hartford railway companies for a union station at this place, 32 × 177 ft., and estimated to cost $25,000.

Dayton, O.—The Big Four, the Panhandle and the Cincinnati, Hamilton & Dayton railway companies are reported as to build a $100,000 station and spend about $100,000 in track elevation provided the city will bear the cost of damages arising from the necessary street changes. The station will not be built unless the city consents to the latter. This proposition is said to be under consideration by the city authorities.

TUNNEL.—Union Hill, N. J.—Sebastian Malbeck, Town Surv., at the instance of Otto Walsheid, an extensive property owner, has prepared plans for a highway tunnel 17 ft. high, 45 ft. wide and about one-fourth of a mile long, connecting the boulevard from Main St. with the West Shore ferry. Such a tunnel would be of great convenience to the residents of this place, Weehawken and West Hoboken, and is estimated to cost about $120,000.

FOUNDATION.—Olympia, Wash.—The following bids were received Nov. 8 for the capitol foundation:

Moffatt Bros., Spokane (awarded contract)	$47,400
Flynn & Rockmark, Seattle	45,980
Northwest Construction Co., Tacoma	46,638
Donald McRae, Seattle	46,531
W. M. Shipley, Sumner	46,800
F. H. Goss, Tacoma	47,540
Cameron, Bye & Co., Seattle	48,750
Nichols & Crothers, Tacoma	49,320
William Welsh, Tacoma	49,700
Gallaher & Cotter, Olympia	49,750
James C. Spurr, Seattle	49,770
J. Huntington, Tacoma	49,900
Huson & Gilmore, Tacoma	51,131
James Parke, Seattle	52,375
A. E. Barrett, Puyallup	56,900
E. J. Payne, Olympia	57,000
N. J. Blagen, Portland	66,000

PIER WORK.—Duluth, Minn.—Maj. C. B. Sears, U. S. Engineer Office, received the following bids, Nov. 10, (1) being for repairs to piers at Ontonagon, Mich., and (2) for repairs at Duluth:

	1.	2.
Samuel Meinlee, Duluth	$5,056	$5,003
Le Doux-Moore Co., West Superior, Wis.	5,170	6,341
Powell & Mitchell, Marquette, Mich.	....	7,036
Thos. Dwyer, West Superior, and Edward J. Armory, Duluth	$4,415	5,733
Louis Meining, Duluth	7,009	6,981
Wisconsin Dredge & Dock Co., Manitowoc, Wis.	5 163	....
Geo. Taylor, Duluth	5,472	6,638
Casgrain & McDonald, Chicago	6,810	....
Wm. McCurdy, Houghton, Mich., and Alex. McCurdy, Duluth	6,383	7,711
Francis L. McDonald, Duluth	5,687	7,537
Jas. E. Smith, Marquette	7,105	8,639
Geo. R. King & Co., Duluth	....	6,548
Wilson & Nauffi, Duluth	....	7,342
David Sang, West Duluth	....	6,732
John Clyne, West Duluth	....	6,586
Fredin & Wilson, Duluth	....	7,074
Willis H. Holden, Duluth	....	5,808
Alex. & David Sang, Duluth	....	6,998
Edward McCure	....	5,699

CONDENSED LIST OF CONTRACTS PENDING WITH DATE OF OPENING BIDS.

Bids to be opened.	Work.	Place.	See Eng. News.
Nov. 23.	Pipe sewers (10,000 ft.),	Warren, O.	Nov. 1
Nov. 23.	River improvement,	Ottawa, Ontario.	Nov. 1
Nov. 23.	Wooden bridges (4),	Kansas City, Mo.	Nov. 8
Nov. 23.	Boiler,	Baltimore, Md.	Nov. 15
Nov. 23.	Truck house,	Newark, N. J.	Nov. 15
Nov. 23.	Water bonds ($35,000),	Port Clinton, O.	Nov. 22
Nov. 24.	Elec. r'y sale,	N. Westminster, B.C.	Nov. 1
Nov. 24.	Steel bridge,	Pittsburg, Pa.	Nov. 15
Nov. 24.	W.-wks. system,	Arlington Heights, O.	Nov. 22
Nov. 24.	Sewer pipe, etc.,	Toronto, Ont.	Nov. 22
Nov. 25.	Paving and curb'g,	South Bethlehem, Pa.	Nov. 15
Nov. 26.	Water supply,	Monroe, Mich.	Nov. 1
Nov. 26.	Bridge,	Houston, Tex.	Nov. 1
Nov. 26.	Water-works system,	Salisbury, Mo.	Nov. 8
	Advertised Eng. News, Nov. 8 to 22.		
Nov. 26.	100-ton shear legs at	Phila. navy yard.	Nov. 15
Nov. 26.	Street improvement,	Lafayette, Ind.	Nov. 15
Nov. 26.	Police station,	Newark, N. J.	Nov. 15
Nov. 26.	Brick (30,000 sq. yds.),	Jacksonville, Fla.	Nov. 22
Nov. 26.	Sewer,	St. Paul, Minn.	Nov. 22
Nov. 27.	Public Building at	Camden, Ark.	Nov. 1
	Advertised, Eng. News, Nov. 1 and 8.		
Nov. 27.	Dredging (3 contracts),	Galveston, Tex.	Nov. 8
Dec. 4.	Boiler house,	Philipsburg, Pa.	Nov. 22
Dec. 4.	Engine houses (3),	St. Louis, Mo.	Nov. 22
Dec. 5.	Bridge,	Baltimore, Md.	Nov. 22
Dec. 5.	Bridge,	Montreal, Que.	Nov. 22
Dec. 5.	Water-wks. system,	Oswego, Ill.	Nov. 22
Dec. 5.	Stone,	Nashville, Tenn.	Nov. 22
Dec. 6.	Street imp'v't bonds,	St. Bernard, O.	Nov. 15
Dec. 6.	Bridge superstructure,	Scranton, Pa.	Nov. 22
Jan. 7.	Water bonds,	Detroit, Mich.	Nov. 15
Dec. 7.	Safety gates,	Brooklyn, N. Y.	Nov. 22
	Advertised, Eng. News, Nov. 22.		
Dec. 7.	Water bonds,	New Bedford, Mass.	Nov. 22
Dec. 8.	Water bonds ($4,000),	Rushford, Minn.	Nov. 22
Dec. 10.	Breakwater extension,	Buffalo, N. Y.	Nov. 8
	Advertised, Eng. News, Nov. 8 to 29.		
Dec. 10.	Water bonds ($100,000),	Steubenville, O.	Nov. 15
Dec. 10.	Electric lighting,	Millville, N. J.	Nov. 15
	Advertised, Eng. News, Nov. 15 and 22.		
Dec. 10.	Water bonds ($6,110),	Montevideo, Minn.	Nov. 22
Dec. 10.	Removing wreck,	Wilmington, Del.	Nov. 22
Dec. 10.	Bridge superstructure,	Warren, O.	Nov. 22
Dec. 10.	Pier work,	Duluth, Minn.	Nov. 22
Dec. 11.	Island protection,	Richmond, Va.	Nov. 22
	Advertised, Eng. News, Nov. 22 and 29.		
Dec. 12.	Electric lights,	Cleveland, O.	Nov. 22
Dec. 12.	Street cleaning,	Cleveland, O.	Nov. 22
Dec. 12.	Oil lamps (4,377),	Cleveland, O.	Nov. 22
Dec. 13.	Water-wks. system,	Morris, N. Y.	Nov. 22
	Advertised, Eng. News, Nov. 22 to Dec. 6.		
Dec. 13.	Bridge superstructure,	Scranton, Pa.	Nov. 22
Dec. 13.	Dike,	Philadelphia, Pa.	Nov. 22
Dec. 14.	Tunnel,	Cleveland, O.	Nov. 22
Dec. 15.	Surveying,	Flemington, N. J.	Nov. 22
	Advertised, Eng. News, Nov. 22 and 29.		
Dec. 17.	Wooden bridge,	Franklin, Neb.	Nov. 8
Dec. 18.	Telephone system,	Washington, D. C.	Nov. 22
Dec. 20.	Brick sewers,	San Antonio, Tex.	Nov. 22
	Advertised, Eng. News, Nov. 22 to Dec. 13.		
Dec. 20.	Pipe sewers,	San Antonio, Tex.	Nov. 22
	Advertised, Eng. News, Nov. 22 to Dec. 13.		
Dec. 20.	Sewer pipe, brick, etc.,	San Antonio, Tex.	Nov. 22
	Advertised, Eng. News, Nov. 22 to Dec. 13.		
Dec. 26.	Electric lighting,	Monroe, Mich.	Nov. 15
No date.	Filter plant,	Key Port, N. J.	Nov. 15
"	Electric light poles (1,500),	Atlanta, Ga.	Nov. 22

CONTRACT PRICES.

LAYING WATER PIPE.—Rochester, N. Y.—The contracts for laying water mains, as advertised in Engineering News, have been awarded to the lowest bidders. The lowest bids were given last week under Water-Works. E. Kuichling, Ch. Engr., has sent us the following statement of the bids received:

Bids Received at Rochester, N. Y., for Laying Water Pipe.

Items.	Group 167. Quan.	Low't bid.	Group 168. Quan.	Low't bid.	Group 169. Quan.	Low't bid.	Group 170. Quan.	Low't bid.	Group 171. Quan.	Low't bid.	Group 172. Quan.	Low't bid.
Earth excavation, cu. yds.	2,145	$0.25	7,100	$0.35	8,200	$0.35	9,750	$0.42	5,950	$0.45	1,200	$0.30
Rock excavation, cu. yds.	230	1.90	10	3.00	25	2.00	150	2.25	10	2.50	250	1.50
Concrete masonry, natural cement, cu. yds.	....	....	10	4.00	10	5.00	10	5.00	10	5.00	....	....
" " Portland cement, cu. yds.	....	....	5	5.50	5	6.00	5	6.00	5	6.00	....	....
Brick masonry, Portland cement, cu. yds.	....	....	50	9.50	35	10.00	50	10.00	35	10.00	....	....
Rubble masonry, natural cement, cu. yds.	....	....	30	4.00	15	4.50	40	4.50	25	4.50	....	....
Screened gravel, cu. yds.	....	....	5	.90	5	1.00	5	1.00	5	1.00	....	....
Broken stone, cu. yds.	....	....	5	1.25	5	1.25	5	1.25	5	1.50	....	....
Pine and oak timber, and planking, ft. B. M.	....	....	5,000	30.00	5,000	30.00	5,000	30.00	5,000	30.00	....	....
Wrought iron work, lbs.	....	....	400	.03	400	.03	400	.03	400	.03	....	....
Old steel or iron rails, lbs.	....	....	10,000	.015	8,500	.03	13,000	.03	13,000	.03	....	....
Cast iron work, lbs.	....	....	1,200	.035	850	.03	1,250	.03	1,250	.03	....	....
Replacing sheet asphalt pavements, sq. yds.	....	....	....	....	....	....	....	....	70	4.00	20	3.00
Other pavem'ts, concrete foundat'n, sq. yds.	....	....	....	....	....	....	80	.25	....	....	....	....
Others without concrete foundations, sq. yds.	5	.25	500	.17	45	.25	230	.25	160	.25	210	1.00
Macadam and gravel, Telf'd foundat'n, sq. yds	....	....	....	....	....	....	2,000	.25	2,000	.25	....	....
Sidewalk pavements, sq. yds	5	1.00	....	..	10	1.00	65	.60	50	.50	10	1.00
Setting fire hydrants in place, number	15	1.50	....	..	....	..	....	..	....	..	6	5.00
Setting 36-in. stop valves and appurten'ces, No.	....	....	3	50.00	2	8.00	4	7.50	....	....	....	....
" 30-in. " " " " "	....	....	....	..	....	..	....	..	3	6.50	....	....
" 24-in. " " " " "	....	....	2	40.00	....	..	....	..	1	5.00	....	....
Setting 36-in. c.i. pipe and spec. c'st'gs, lin. ft.	....	....	4,550	.70	5,300	.71	6,300	.75	....	....	....	....
" 30-in. " " " " "	....	....	....	..	....	..	....	..	3,930	.62	....	....
" 24-in. " " " " "	....	....	30	.50	....	..	....	..	10	.60	....	....
" 20-in. " " " " "	....	....	....	..	....	..	....	..	480	.45	....	....
" 16-in. " " " " "	290	.40	20	.40	....	..	35	.30	....	..	10	.75
" 12-in. " " " " "	....	....	....	..	40	.22	60	.22	40	.22	2,190	.20
" 10-in. " " " " "	10	.16	....	..	....	..	....	..	20	.20	....	....
" 8-in. " " " " "	690	.14	....	..	20	.14	20	.15	....	..	....	....
" 6-in. " " " " "	4,185	.10	....	..	50	.12	75	.12	30	.12	60	.20
" 4-in. " " " " "	160	.09	....	..	....	..	....	..	....	..	....	....
Total amount of lowest bid	$1,649.10		$7,065.25		$7,689.10		$11,200.45		$7,541.50		$1,502.50	
Name of lowest bidder	W. Fuller.		Chambers & Casey.		Brayer & Albaugh.		Brayer & Albaugh.		Brayer & Albaugh.		Bruff, Horn & Co.	

The total bids were as follows:

Bidder.	Group 167.	Group 168.	Group 169.	Group 170.	Group 171.	Group 172.
William Fuller, Rochester, N. Y.	$1,649	$7,932	$8,745	.....	.....	$1,508
Bruff, Horn & Co., Rochester, N. Y.	1,745	17,341	13,161	$16,489	$13,106	1,502
David Clancy, Rochester, N. Y.	1,754	.....	.....	.....	.....	.....
Lauer & Hagaman, Rochester, N. Y.	1,770	8,341	8,968	12,461	8,751	.....
Thomas Holahan, Rochester, N. Y.	1,929	10,831	11,907	.....	.....	1,894
Chambers & Casey, Rochester, N. Y.	2,151	7,065	8,155	12,206	7,410	2,051
Brayer & Albaugh, Rochester, N. Y.	2,368	7,529	7,689	11,200	7,541	.....
Thomas Grady, Rochester, N. Y.	.....	.....	.....	.....	17,021	.....
Whitmore, Rauber & Vicinus, Rochester, N. Y.	.....	8,946	9,698	14,346	10,443	.....
Henry L. Jones, Rochester, N. Y.	.....	9,128	9,136	14,593	8,684	1,808
Thomas F. Moore, Buffalo, N. Y.	.....	9,694	10,339	14,345	10,758	.....

Nov. 27. Electric light plant, Anaheim, Cal. Nov. 22
Nov. 28. Pumping engines, Allegheny, Pa. Nov. 8
Nov. 28. Outlet sewer, Hoboken, N. J. Nov. 15
Nov. 28. Grading, Haughville, Ind. Nov. 15
Nov. 28. Dock work, New York, N. Y. Nov. 22
Nov. 28. Ditch work, Wheatfield, N. Y. Nov. 22
Nov. 28. Brick pav'g (20,000 sq. yds.), Sandusky, O. Nov. 22
Nov. 28. Wells, Brightwood, Ind. Nov. 22
Nov. 28. Elevators, etc., Denver, Colo. Nov. 22
Nov. 30. Interior bldg. work at St. Albans, Vt. Nov. 8
Advertised, Eng. News, Nov. 8 and 15.
Nov. 30. Machine tools, Watertown Arsenal, Mass. Nov. 15
Nov. 30. Channel work, Richmond, Va. Nov. 15
Nov. 30. Pipe sewers, Newark, N. J. Nov. 22
Nov. 30. Ry. ties, fencing, etc., Yarmouth, N. S. Nov. 22
Dec. 1. Electric lighting, Ann Arbor, Mich. Oct. 11
Dec. 1. Sewer, Rochester, N. Y. Nov. 22
Dec. 1. Brick paving, Massillon, O. Nov. 22
Dec. 3. Water-works system, Newton, N. J. Nov. 8
Advertised, Eng. News, Nov. 8 and 15.
Dec. 3. Pier, Ottawa, Ont. Nov. 8
Dec. 3. Sidewalks, Sioux City, S. Dak. Nov. 15
Dec. 3. Bridge, Rome, N. Y. Nov. 22
Dec. 3. Sewers, Ashtabula, O. Nov. 22
Dec. 3. Water bonds, Cadiz, O. Nov. 22
Dec. 3. Railway (10½ miles), Moncton, N. B. Nov. 22
Dec. 4. Grading, etc., New York, N. Y. Nov. 22

HARBOR WORK.—Milwaukee, Wis.—Maj. Jas. F. Gregory, U. S. Engineer Office, received the following lowest bids on Nov. 6: Hier B. Herr & Co., Chicago, breakwater extension, Harbor of Refuge at Milwaukee Bay—325,000 ft. pine timber, $19 per M. ft.; 225,000 ft. hemlock, $15.50; 2,700 ft. pine plank, $15; 3,300 cords stone, $5.75; 48,500 lbs. wrought iron drift bolts, 2 cts.; 1,000 lbs. wrought iron screw bolts, 3 cts.; 2,000 lbs. wrought iron spikes, 3 cts.; total for 300 ft., $29,738; pier extension at Kenosha, Wis.—98,000 ft. pine timber, $19.50; 95,000 ft. hemlock timber, $15.50; 9,200 ft. pine plank, $15; 475 cords stone, $6; 76 foundation piles, $8 each; 24 white oak piles, $9.50; 16,000 lbs. wrought iron drift bolts, 3 cts.; 3,600 lbs. wrought iron screw bolts, 3 cts.; 450 lbs. wrought iron spikes, 3 cts.; total, $7,809; pier extension at Waukegan, Ill.—16,650 lin. ft. white oak round piles, 20 cts. per lin. ft.; 56,160 ft. Wakefield sheet piling, $24.50; 15,480 ft. white oak timber, $36; 8,688 ft. white pine timber, $21; 2,160 ft. white pine plank, $16; 760 cords stone, $6; 10,000 lbs. wrought iron screw bolts and tie rods, 3 cts.; 500 lbs. wrought iron spikes, 3 cts.; total, $9,995. F. M. Knapp & E. Gillen, Racine, Wis., pier extension at Racine, Wis.—117,000 ft. pine timber, $18.95; 110,000 ft. hemlock timber, $14; 10,300 ft. pine plank, $16.50; 650 cords stone, $6; foundation piles No. 84, $8; white oak piles No. 16, $8.25; 19,250 lbs. wrought iron drift

bolts, 2 cts.; 3,880 lbs. wrought iron screw bolts, 3 cts.; 325 lbs. wrought iron spikes, 2 cts.; total, $9,141. The other bidders for these contracts were as follows: August Lantz, Milwaukee, Wis; William A. Starke, Milwaukee, Wis.; Wisconsin Dredge & Dock Co., Manitowoc, Wis.; John E. Hathaway, Milwaukee, Wis.; I. W. Galloway, Racine, Wis.; Francis L. McDonald, Duluth, Minn.; Donald McLeod & William McLeod, Manistee, Mich.; Edward G. Crosby, Muskegon, Mich.; Dion Geraldine & Wm. G. Derbyshire, Chicago, Ill.; Francisco Blair, Chicago, Ill.; Powell & Mitchell, Marquette, Mich.; Kissack & Muir, Chicago, Ill.; Martin Hausler & Theodore C. Lois, South Chicago, Ill.; G. W. Crouter & John Monroe, Jr., Charlevoix, Mich.; John M. Allmendinger, Benton Harbor, Mich.; McGrath & Anderson, Green Bay, Wis.; Lydon & Drews, Chicago, Ill.; Green's Dredging Co., Chicago, Ill.; Rieboldt, Wolter & Co., Sheboygan, Wis.; A. R. Ferguson, Manistee, Mich.

HYDRANT COVERS AND EXTENSION CASES.—Buffalo, N. Y.—The contract for 600 or more iron hydrant covers and 100 extension cases has been awarded to the Forest City Wire & Iron Co., at $3.60 for each hydrant cover and 84 cts. for each extension case. The Forsyth Mfg. Co., Buffalo, submitted a lump bid of $2,420. The other bids were as follows:

	Hyd. cov.	Ext'n case.
Forest City Wire & Iron Co., Cleveland	$3.60	$0.84
P. C. Newkirk & Co. Buffalo	3.68	0.84
Machwirth Bros., Buffalo	3.75	0.95
Frederick H. Menge, Buffalo	3.87	0.50
Riter Bros., Buffalo	3.98	0.73
Mensch Bros., Buffalo	4.05	0.99
Charles F. Ernst, Buffalo	4.13	0.80
Philip Wertz, Buffalo	4.09	1.14

DREDGING.—Wilmington, N. C.—Maj. W. S. Stanton, U. S. Engineer Office, received the following bids Nov. 7 for dredging in Lockwood's Folly River, N. C., as advertised in Engineering News: Cordes & Brockman, Charleston, S. C., 24 cts. per cu. yd.; Florida Dredging Co., Tampa, Fla., 25 cts.; Fred. E. Jones, Charleston, S. C., 20 cts.; Virginia Dredging Co., Richmond, Va., 19 cts. (awarded contract); Louis H. Skinner, Wilmington, N. C., 26 cts.

DREDGING AND FILLING.—Toronto, Ont.—The committee on parks has awarded a contract for 36,000 cu. yds. of work at Island Park to Doty Bros., at 11 cts. per cu. yd. for dredging and 7 cts. per cu. yd. for the filling and leveling.

SEWERS.—Cranford, N. J.—Bids were opened by Carrol Ph. Bassett, Ch. Engr., Nov. 8, for constructing an outlet sewer, as advertised in Engineering News. The work is in two sections and two sets of bids were received for each section, line 1 being for a sewer with capacity for Cranford and Westfield, and line 2 for sewer for Cranford alone. The prices below were the bids for line 2 of section B. In line 1 of section B the specifications called for 24 and 18-in. vitrified pipe and 18-in. iron pipe:

Nov. 12, F. E. Cole receiving three contracts and Wm. J. McMahon one. The prices were 58 cts. and 86 cts. per ft. for 24-in. sewers and 80 cts. and 75 cts. for 20-in. sewers.

LEVEE WORK.—Memphis, Tenn.—The following contracts for levee construction were awarded by Capt. M. D. Townsend, U. S. Engr. Office, Nov. 16: L. C. Dulany, 100,000 cu. yds. at 11.88 cts. per cu. yd.; also 40,000 cu. yds. at 11 cts.; Whitehall & Co., Arkansas City, Ark., 98,000 cu. yds. at a minimum bid of 11.73 cts.; Chas. H. Dameron, of Friars Point, Miss., 57,000 cu. yds., at 11 cts.; Messrs. Tally, of Memphis, and Charles Dameron, of Friars Point, each bid 9 cts. on 125,000 cu. yds. between Wilton and Salem.

METAL MARKET PRICES.

LEAD.—New York: 3.10 to 3.12 cts. Chicago, 2.97 cts. St. Louis: 2.92 to 2.95 cts.

NAILS.—Pittsburg: 95 cts. to $1.05 for wire, and 90 cts. for cut at mill, in carload lots.

BARBED WIRE.—Pittsburg: galvanized, $1.95 to $2.05; plain, $1.2 to $1.25 for carloads at mill.

FOUNDRY AND PIG IRON.—New York: $10 to $13. Pittsburg: $10.75 to $11.75. Chicago: $9.50 to $11.50.

TRACK MATERIAL.—New York: angle bars, 1.25 to 1.4 cts.; spikes, 1.55 to 1.7 cts.; track bolts, 2 to 2.1 cts. with square, and 2.15 to 2.3 cts. with hexagon nuts. Chicago: angle bars, 1.3 to 1.35 cts.; spikes, 1.7 to 1.75 cts.; track bolts, 1.9 to 2 cts., with hexagon nuts.

RAILS.—New York: $24 at eastern mills and at tidewater; old rails, $11 to $12 for iron and $9 to $10 for steel; steel rails, fit for relaying, $16 to $19; light rails, $22 to $24; girder rails, $24. Pittsburg: $24 to $25 for standard sections; old rails, $12 to $12.50 for iron and $10 to $10.50 for steel. Chicago: $25 to $27; old rails, $10.75 to $11.25 for iron and $7.50 to $10 for steel.

STRUCTURAL MATERIAL.—New York: beams, 1.3 to 1.5 cts.; channels, 1.35 to 1.5 cts.; angles, 1.25 to 1.35 cts.; tees, 1.4 to 1.6 cts.; universal mill plates, 1.25 to 1.35 cts.; steel plates, 1.25 to 1.4 cts. for tank, 1.4 to 1.5 cts. for shell, 1.6 to 1.65 cts. for flange, 1.75 to 2 cts. for ordinary firebox, 2 to 2.25 cts. for locomotive firebox. Pittsburg: beams, 1.2 to 1.3 cts.; channels, 1.2 to 1.3 cts.; angles, 1.15 to 1.2 cts.; tees, 1.35 to 1.4 cts.; universal mill plates, 1.15 to 1.2 cts.; steel plates, 1.2 to 1.3 cts. for tank, 1.3 to 1.35 cts. for shell, 1.35 to 1.4 cts. for flange, 2.5 to 3.75 for ordinary firebox, and 3.35 to 3.5 cts. for locomotive firebox. Chicago: beams, 1.5 cts.; channels, 1.5 cts.; angles, 1.4 to 1.45 cts.; tees, 1.65 cts.; universal plates, 1.4 to 1.45 cts.; steel plates, 1.4 to 1.5 cts. for tank, 1.65 to 2.1 cts. for flange, 1.65 to 5 cts. for firebox.

PIPES AND TUBES.—The "Iron Age" states that trade is very fair considering the season of the year, but is confined to ordinary business, no large orders having been placed for some time. Prices are unchanged and depend to a considerable extent upon the

THE CHAUTAUQUA CEMENT CO., of Cassadaga, N. Y., held its annual meeting last week. The plant includes a main building 50 by 100 ft. and three stories high, another building 65 by 60 ft., power house 75 by 40 ft., and a laboratory. Pres., Frank E. Shaw, Dunkirk, N. Y.; Secy., E. S. Allen, Cassadaga, N. Y.

THE LIMA LOCOMOTIVE & MACHINE CO., of Lima, O., manufacturing locomotives, freight cars and railway equipment, has purchased the plant of the Lima Steel Castings Co., and the plant has been thoroughly overhauled and rebuilt and put in operation. It is equipped with a 10-ton open-hearth furnace.

THE MOUNT VERNON-CAR MFG. CO., of Mount Vernon, Ill., is building 225 box cars for the Mexican Central Ry., and they will be equipped with Westinghouse air-brakes and Fox pressed steel trucks. The company is also building 15 fruit cars for the Florida Central & Peninsular Ry., and 12 Hicks stock cars. It has also an order for repairing 500 cars.

THE SOUTHERN PHOSPHATE WORKS at Macon, Ga., were burned Nov. 18. The buildings included a four-story mill building 356 × 125 ft., acid chamber, three stories, 300 × 40 ft., and a storage building 200 × 50 ft., all of which, with their contents, were lost. The buildings were constructed of brick and wood. The loss is about $125,000. The plant will be rebuilt. Pres., Thomas Henley; Supt., W. W. Frank.

THE HEATH RAIL JOINT CO., of Minneapolis, Minn., reports that its works at Chicago Heights, Ill., are turning out 1,500 joints per day, and that the output is expected to be increased to 2,000, as the company is behindhand with its orders. The works have oil-furnace capacity to heat 3,000 plates 11 × 24 × ⅝ in. in ten hours, one 10-HP. and three 20-HP. steam hammers, a 20-HP. double shearing machine, double punching machine, electric plant and machine shop.

THE BEAVER TIN PLATE CO., of New Lisbon, O., is erecting a tin-plate plant with an iron main or mill building 200 by 100 ft., brick tin house 60 by 184 ft., iron annealing house 70 by 80 ft. and iron boiler house 45 by 60 ft. The boiler house will have a capacity of 600 HP. The foundations are being put down for a six-mill train of hot rolls, though only four will be put in at present. The foundations for the cold rolls of four mills have already been completed. The engine to drive the hot mills will have cylinders 32 × 60 ins. and that for driving the cold mills 26 × 48 ins., and both will be of the Corliss type. Electrical cranes will be installed, one of 12 tons capacity in the main building and one of 5 tons capacity in the annealing house. Pres., Charles W. Bray.

THE CONSOLIDATED CAR-HEATING CO., of Albany, N. Y., has an order from the People's Traction Co., of Philadelphia, for the equipment of 300 cars with its system of electric heating. This is said to be the largest order ever given for electric heaters. Other large orders recently received include 149 car equipments for the West End Ry., Boston; 187 for the

Bids Received at Cranford, N. J., Nov. 8, for Constructing Section B of Outlet Sewer.

Bidders.	20-in. vitrified pipe, 18,867 ft.	15-in. vitrified pipe, 4,966 ft.	14-in. iron pipe, 510 ft.	20-in. Y's, 12.	15-in. Y's, 12.	Manholes, less than 12 ft., 560 ft.	Manholes, more than 12 ft., 130 ft.	Manhole sand cts. 60.	Manhole drops, 10 ft.	Lampholes, 50 ft.	Silt basins, 25.	Concrete, 1,500 cu. yds.	Iron castings, 28,000 lbs.	Cast iron pipe, 7 gross tons.	Timber foundations, 100 M. ft.	Sheathing, 240 M. ft.	6-in. piles, 1,000 ft.	Stray, below grade, 600 cu. yds.	4-in. under drain, 2,000 ft.	6-in. under drain, 2,000 ft.	8-in. under drain, 2,000 ft.	Totals —Section B.— Line 2.	Line 1.	—Section A.— Line 2.	Line 1.
Harris Regert, Brooklyn, N. Y.	$1.75	$1.05	$1.50	$1.63	$0.66	$2.34	$3.34	$1.25	$0.09	$1.50	$103.00	$4.00	$.0175	$25.00	$25.00	$23.00	$0.09	$0.30	$0.25	$0.30	$0.35	$59,116	$65,709	$38,204	$38,251
*Abbott-Gamble Construct'n Co.	1.93	.93	2.40	1.95	.95	2.65	3.29	1.00	2.10	1.03	5.42	5.50	.03	23.00	16.00	16.00	.06	.60	.13	.16	.90	61,515	70,106	.....	.....
H. M. Dowd & Co., Orange, N. J.	3.25	.74	2.00	1.00	1.00	2.00	2.50	1.00	1.00	1.00	5.00	1.00	.02	60.00	16.00	15.00	.40	.05	.05	.10	.15	75,339	82,818	58,487	62,911
W. H. Waters, Bayonne, N. J.	2.50	1.40	3.00	1.50	1.00	2.00	2.50	1.00	.30	1.00	3.00	1.00	.03	20.00	1.00	15.00	.40	.20	.10	.12	.15	64,433	72,855	29,164	31,792
T. Redding, Perth Amboy, N. J.	1.60	.95	2.00	1.40	.79	3.35	3.50	1.00	2.00	1.35	40.00	2.75	.02	20.00	22.00	15.00	.30	.75	.30	.40	.60	53,066	63,096	33,613	35,245
W. Chamberlain, Rahway, N. J.	2.50	2.00	2.00	.80	.65	2.25	2.00	.50	2.25	.50	50.00	2.50	.025	35.00	16.00	14.00	.25	.60	.08	.10	.12	71,445	78,601	.....	.....
Jas. Smith & Son, Easton, Pa.	2.41	.96	3.75	3.00	1.00	2.75	3.25	3.00	2.75	2.00	5.00	3.00	.035	45.00	8.00	14.00	.75	.75	.50	.60	.75	69,353	83,905	34,372	37,75-
T. Siddall & Co., Trenton, N. J.	3.04	1.80	2.10	2.35	1.25	4.00	4.50	6.00	.90	1.00	50.00	4.50	.025	25.00	30.00	15.00	.18	1.00	.05	.70	.75	101,818	109,456	.....	.....
Costa & Marino, Orange, N. J.	1.50	1.00	1.20	1.40	.80	2.50	3.00	.50	1.50	1.00	4.75	1.00	.02	16.00	8.00	10.00	.25	.50	.25	2.00	2.20	50,468	58,131	32,220	35,092
**McGuire, McKnight & Co.	2.61	1.35	3.30	2.00	1.00	3.50	4.75	7.00	1.00	1.50	6.00	5.00	.025	35.00	10.00	9.00	.20	.80	.33	.35	.38	75,059	82,678	.....	.....
Bernard Brady, Plainfield, N. J.	2.02	1.85	3.00	2.73	1.80	2.00	2.50	3.00	1.00	1.00	5.00	5.00	.02	30.00	1.00	1.00	.25	1.00	.40	.50	.65	80,311	95,631	40,408	42,290
Smith & Burden, L. I. City, N. Y.	2.65	1.75	4.50	2.25	1.00	2.75	3.00	2.00	2.00	1.20	2.00	5.00	.03	29.00	22.50	20.00	.37	.50	.63	.68	.75	82,972	96,906	47,428	51,069

* St. Louis, Mo. ** Round Brook, N. J.

PAVING AND RETAINING WALL.—Columbus, O.—Contracts were awarded, Nov. 7 as follows: Warren-Scharf Asphalt Paving Co., paving with asphalt, at $2 per sq. yd.; N. B. Abbott, paving with Hallwood blocks, at $1.17; John Carroll, retaining wall, 15 cts. per cu. yd. for excavation, $1.88 for limestone wall, 20 cts. for filling and 75 cts. per lin. ft. for coping.

LEVEE WORK.—Memphis, Tenn.—Capt. S. W. Roessler, U. S. Engineer Office, has recommended that four contracts, aggregating 500,000 cu. yds., be awarded to Foster & Co., of this city, at 9½ cts. per cu. yd. The levees to be constructed are on the Arkansas side of the Mississippi River, near the Missouri state line.

PIPE.—Bedford City, Va.—The contract for supplying cast iron pipe for the new water supply has been awarded to the Glamorgan Co., Lynchburg, at $18.65 per ton, according to press reports.

Attica, O.—L. L. Sutton, Clk., informs us that the contract for cast iron pipe for the new water-works was awarded Nov. 13 to the Ohio Pipe Co., Columbus, at $18.74 per ton for 8-in. pipe, $18.83 for 6-in., $19 for 4-in. and 2 cts. per lb. for special castings.

SEWERS.—Sandusky, O.—The following bids were received Nov. 3 for constructing the Madison St. sewer; (1) being price per lin. ft. for 1,200 ft. of trenching 11½ ft. deep, 60% rock and balance clay, for brick sewer; (2) 3,900 ft. of trenching 10 ft. deep, 70% rock and balance clay, for pipe sewer; (3) price per lin. ft. for 1,200 ft. of 24 × 36-in. brick sewer, 4-ring; (4) 15 to 8-in. pipe sewer; (5) price per manhole for 24 manholes, to be of stone, 12-in. walls and cast iron covers; (6) price per catch basin for 27 catch basins, cast iron, price including 10-in. connection with manhole; all mortar to be of Portland cement 1 part, sand 3 parts:

	1. $	2. $	3. $	4. cts.	5. $	6. $	Total. $
James Conley	1.31	1.31	1.07	.27 to .135	18.00	25.50	9,893
C. Schoepfle & Son	1.70	1.38	.65	.27 " .12	15.00	22.00	9,921
G. J. Doersback	1.75	1.80	.60	.28 " .10	14.00	14.25	9,323
John McKean	1.45	1.45	.92	.25 " .12	14.00	21.00	10,184
M. J. Callan	1.35	1.15	.97	.27 " .11	18.00	22.00	9,067

Toledo, O.—L. P. Harris, Cy. Clk., writes us that contracts for four small brick sewers were awarded

size and nature of the order. Boiler tubes 70 and 10% on 2¼-in. and smaller and 75 and 10% on 2¼-in. and larger, in carload lots.

INDUSTRIAL NOTES.

THE TENNESSEE PAVING BRICK CO., of Robbins, Tenn., has shipped paving brick to Jacksonville, Fla., for paving 75,000 sq. yds. of street.

MR. D. J. KENNEDY'S paving block factory at South Bay City, Mich., was destroyed by fire Nov. 9, involving a loss of $8,000. It will be rebuilt.

THE NEW YORK LOCOMOTIVE & MACHINE CO., of Rome, N. Y., has rebuilt its shops, which were burned nearly a year ago, and is ready to resume business.

THE LOUIS K. COMSTOCK CO., of Chicago, carrying on an electrical engineering and contracting business, has opened an office in the Hodges Building, Detroit, Mich.

THE EUREKA STEEL CASTINGS CO., of Chester, Pa., has failed, owing to the financial depression and several disastrous fires. Its managers hope soon to be able to resume business.

THE AMERICAN PIPE CO., of South San Francisco, Cal., has built a plant for the manufacture of bituminous pipe, which is said to be strong, non-conducting, non-corrosive and impervious to alkalies or acids.

THE BROOKS LOCOMOTIVE WORKS, of Dunkirk, N. Y., have built for the Illinois Central R. R. two passenger engines with cylinders 18 × 24 ins. and driving wheels 5 ft. 9 ins. in diameter, to haul the fast limited trains between New Orleans and Jackson, Miss.

THE NATIONAL SWITCH & SIGNAL CO. has just closed a contract with the Chicago, Milwaukee & St. Paul Ry., through Mr. Geo. Gibbs, Mechanical Engineer, for an interlocking plant, to be erected at Grayland, Ill., to protect an electric street car crossing with the Gibbs system.

Union R. R., Providence; 60 for the Nassau Electric Ry., Brooklyn; and these, with many other smaller orders, aggregate, in all, about 500 car equipments. This company's electric heater is the only one that received an award at the Columbian Exposition, a medal and diploma being given to it for efficiency and economy of operation, combined with admirable regulation of temperature. The heater is now in use in 100 cities and towns of the United States and Canada and on over 1,300 cars.

NEW COMPANIES.—Automatic Tank & Boiler Feed Co., Cleveland, O.; $10,000; V. A. E. Dustin, George A. Eddy and H. W. Wolcott.

White Locomotive Works, Buffalo, N. Y.; $2,000,000; John S. White and W. W. Scott.

Cooke Automatic Stoker Co., Rochester, N. Y.; $10,000; William H. Cooke and Calvin L. Stowell.

Chicago Steel Construction Co., Chicago, Ill.; $25,000; Cecil C. Kent, H. A. Devault and C. H. Hewitt.

Killbuck Brownstone Co., Killbuck, O.; $50,000; Lewis P. Schaus, Chas. E. Duer and George Adams.

Pneumatic Steel Warehouse Co., Chicago, Ill.; $200,000; H. E. Broughton, John C. Ross and William Nash.

New Haven Pipe Co., St. Louis and New Haven, Mo.; $10,000; A. S. Speirs, James Smith and Wentworth Terry.

St. Louis & Illinois Construction Co., East St. Louis, Ill.; $20,000; William Berry, John Dean and W. H. Clancy.

Chandler Engine Co., Newark, N. J.; $100,000, commencing with $10,000; Chas. F. Chandler, Newark; C. Willcox, East Orange.

Provident Gas Improvement Co., Newark, N. J.; $300,000,, commencing with $1,000; David Kay, Jr., Newark; W. S. Chamberlin, Bayonne.

Shedlock Automatic Brake Co., Jersey City, N. J.; $250,000, commencing with $1,000; Alfred Shedlock, Jersey City; W. H. Foster, Elizabeth.

General Equipment & Improvement Co., New York, N. Y.; $100,000, commencing with $1,000; J. Farrell, New York; W. Deary, Brooklyn; N. Y.

Druid Brick Co., Baltimore, Md.; $40,000; Nicholas G. Penniman, Griffin Cook and George M. Harding.

A. R. Clark & Co., Chicago, Ill.; $5,000; general contracting; A. R. Clark, H. B. Lind and T. K. Scott.